The AMSAT® Journal

Editor
Russ Tillman, K5NRK
Editorial Staff
Ron Long, W8GUS
Andy Reynolds, WD9IYT
John Bubbers, W1GYD

Volume 23, No. 6 November/December 2000

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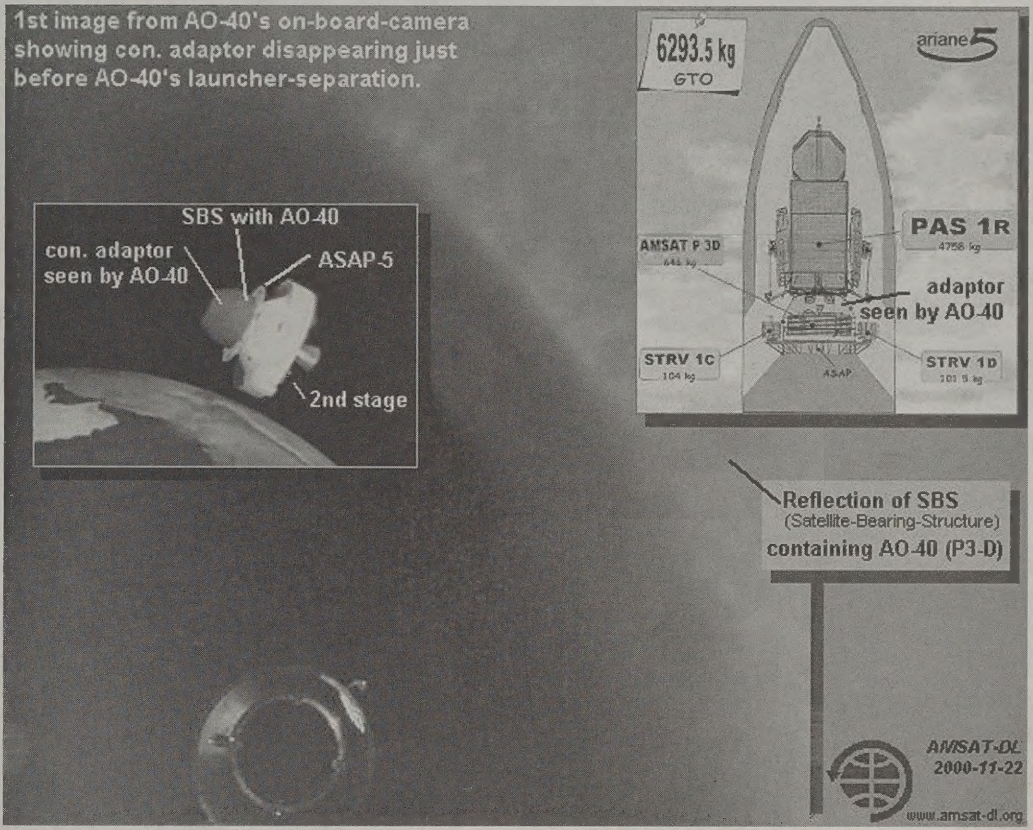

AMSAT Phase 3D/AO-40 Camera Image, by James Miller, G3RUH. The above image was taken by AO-40 during the payload separation phase of the Arianespace V-135 launch that occurred on 16NOV00. The event shown is the detachment of the 2624x1663mm conical adapter assembly that had been the support for satellite PAS-1R. The JPEG image is 512x512 pixels, format 256 gray scale, and the camera field of view is 20.74 deg square. This picture was taken approximately 50 seconds before the AMSAT P3-D satellite was separated from the launcher. It belongs to a series of images which were taken with 5 second spacing and were stored in the memory of IHU-2. The camera which took these images was built by AMSAT-DL and uses a Fuga 15d CMOS, pixel addressable imager from C-CAM Technologies of Heverlee, Belgium. The very fast JPEG compression code for the SA-1100 processor was supplied under a generous license by ARM, Ltd. of Cambridge, England. Some of the images were corrupted in memory by radiation however, so special thanks to J. David Barrow, RiscOS programmer and JPEG innards expert, for locating and flipping the single bit errors in those images, thus rendering them useful. The entire series of images can be viewed via *http://www.amsat-dl.org/journal/adljyace.htm*

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TS-2000
Then There Was Light…
World's 1st HF Backlit Front Key Panel
…The All New TS-2000 Multi Band/Multi Mode Transceiver
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The all new Kenwood **TS-2000** series transceiver offers today's demanding Amateur operator high performance standards without the compromising limitations found in other similar multi-band, multi-mode transceivers. The **TS-2000** offers users three distinct operation platforms, the traditional transceiver with full function front panel, or the high-tech looking "silver box" version that allows mobile operation with the new RC-2000 compact control head, or the ARCP-2000 computer control program making the **TS-B2000** functional from your personal computer. The new **TS-2000** offers 100 watts on HF, 6 meters and 2 meters, 50 watts on 70cm, and when you install the optional UT-20 1.2 GHz module at 10 watts, you will have assembled the most complete dual receiver multi-mode transceiver ever produced. If you are waiting for PH3D, you will be happy to know the **TS-2000** is transverter frequency display function ready to work the latest satellite frequencies available.

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Apogee View

Radio Amateur Satellite Corporation (AMSAT-NA)
850 Sligo Ave., Silver Spring, MD 20910-4703
Telephone: 301-589-6062 Facsimile: 301-608-3410
AMSAT-NA Club Callsign - W3ZM
AMSAT-NA WWW: http://www.amsat.org

The AMSAT Journal Staff
Vice President, Publications: Russ Tillman, K5NRK
Circulation: Martha Saragovitz
(*martha@amsat.org*)
Ron Long, W8GUS
Andy Reynolds, WD9IYT
John Bubbers, W1GYD

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Editorial Office: Russ Tillman, K5NRK, 110 Camden Drive, Vicksburg, MS, 39183-1203, Internet: *k5nrk@amsat.org*, telephone: 601-634-6398, and fax: 601-638-2131.

Advertising Office: AMSAT-NA Headquarters, 850 Sligo Avenue, Suite 600, Silver Spring, MD 20910-4703.

The AMSAT Journal (ISSN: 1407-3076) is published bi-monthly (Jan, Mar, May, Jul, Sep, Nov) by AMSAT-NA, 850 Sligo Avenue, Suite 600, Silver Spring, MD 20910-4703. Telephone: 301-589-6062, fax: 301-608-3410. Periodicals postage paid at Silver Spring, MD, and additional mailing offices. Postmaster, send address changes to *The AMSAT Journal*, 850 Sligo Avenue, Suite 600, Silver Spring, MD 20910-4703.

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The AMSAT Journal staff is always interested in article submissions. Whenever possible, text should be on IBM compatible diskettes with hardcopy or original photographs or figures. AMSAT-NA reserves the right to select material for *The AMSAT Journal* based on suitability of content and space considerations. The editors of this publications are volunteers giving freely of their talents, time, and efforts to produce *The AMSAT Journal*.

Exciting Times

It all seems to be happening at once, the activation of the ISS Alpha Amateur Radio station and the successful launch of Phase 3D/AO-40 as well as the recent launches of satellites for Saudi Arabia and Malaysia. We are very fortunate that so much is happening in the field of Amateur Radio, and in particular in the satellite area. While it will take several months before AO-40 is fully activated, plenty of opportunity exists to track this satellite via the beacons and to download the telemetry. There may also be times when limited operation can take place before AO-40 is fully operational. Meanwhile we have the opportunity to install equipment to use some of the new bands. I suspect that my favorite mode will be SSB using L band uplink to the Satellite and S band downlink. I certainly remember using the S Band downlink on AO-13, and even though that satellite had a very low output I received it S3 and Q5 with a simple converter to 2m mounted at my small dish. The increased power together with gain antennas on AO-40 will make S-Band a joy to receive, and I look forward to using my FT-736 as the uplink transmitter on L band.

AMSAT holds it's Annual Meeting in the fall of every year. This year we met in Portland Maine; the meeting was very well hosted by George W1ME, and Caroline Caswell, WA1MER and was a great success, with excellent papers during the symposium and a great banquet with many prizes. Congratulations to George and Caroline for a job well done.

The Annual Meeting is one time in the year that the Board of Directors get together and discuss the operation of AMSAT, and lay plans for the next 12 months. At this years meeting Keith Baker, KB1SF resigned as President, having spent two years fulfilling that role preceded by six years as the Executive Vice President. Let me thank Keith for the great job he has done over the past eight years. His leadership was excellent and he always managed to handle tricky problems with skill and finesse. Keith has left the AMSAT organization in good shape. Although Keith has retired as President, he has assumed the title of 'Immediate Past-President' and has offered to be of assistance wherever practical.

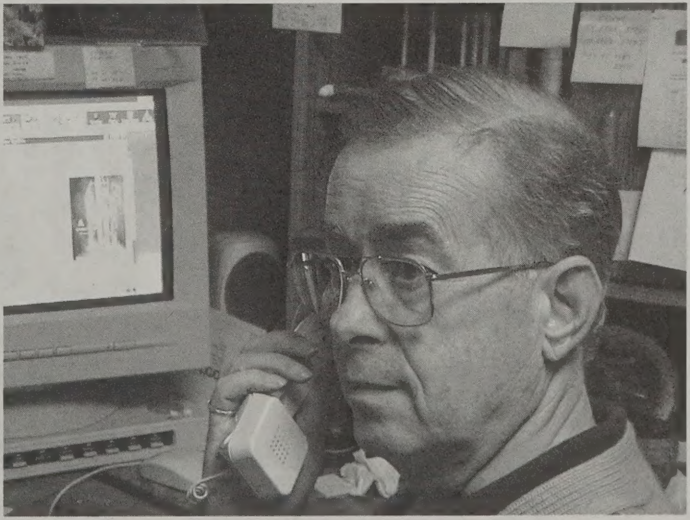
At that same Board of Directors meeting I was appointed to become the new President of AMSAT, and I thank the Board of Directors for honoring me with the position, especially as it is the first time that a person from outside of the USA has been so honored. At this time, I can promise you that I will work hard on your behalf to keep AMSAT as a successful and thriving organization, in which the membership will have every opportunity to be active and participate in our operations.

Also, I welcome back Ray Soifer, W2RS to the position of Executive Vice President. Ray held this position in the early 1990s but had to give it up due to business commitments. Ray's experience in his new role together with his experience in the role of Vice President for International Affairs, will be of great help in steering the organization over the next few years.

One last thought, Martha, our Corporate Secretary and Office Manager, advises me that our membership has started to expand again so if you, or someone you know, requires assistance in getting on the satellites, don't be afraid to call the nearest AMSAT Area Coordinator for assistance. An Area Coordinator may not know the exact solution to your problem, but it is quite likely that he/she will know a person who can help. While we publish the names of the Area Coordinators in this journal and www.amsat.org quite regularly. If you are having some problem finding one, then e-mail our Vice President of Field Operations Barry Baines, WD4ASW and he will let you know who the nearest Area Coordinator is to your location. Barry's e-mail address is *wd4asw@amsat.org*.

Finally I would like to thank *The AMSAT Journal* Editor, his assistants, and the authors who contributed to our recent "Special Phase 3D Edition." As with every edition, this was a joy to read and a surprise when it was found in our mailboxes.

73, Robin Haighton, VE3FRH, President ■



AMSAT President Robin Haighton, VE3FRH providing AMSAT Launch Net Commentary via landline from his QTH in Burlington, Ontario, Canada.

AMSAT Meets in Portland on the Eve of Phase 3D's Launch

During 27-29 October 2000 and shortly before the launch of Phase 3D, over 175 AMSAT-NA members met in Portland, Maine for the 18th AMSAT Annual Meeting and Space Symposium. Congratulations to George W1ME and Carolyn Caswell, WA1MER for assembling a fantastic meeting as once again, participants left the meeting re-energized for another year of satellite experimentation. Numerous technical papers were presented during the symposium and published in the Proceedings. Among papers presented were:

ARISS

- *A Spread Spectrum Wideband Transponder for the International Space Station*, Matt Ettus, N2MJI
- *Amateur Radio On-Board the International Space Station*, Frank Bauer, KA3HDO and Will Marchant, KC6ROL

Phase 3D

- *Phase 3D Launch Campaign Overview and Update*, Dick Daniels, W4PUJ and Lou McFadin, W5DID
- *Phase 3D: A Primer on High Frequency Operation*, Ed Krome, K9EK

Proposed Satellites

- *Modular Nanosatellites as Amateur Radio Communication Platforms*, Amish Parashar, KE6EZM and Todd Kerner, KB2BCT
- *CubeSat: The Next Generation of Educational Picosatellites*, Bob Twiggs, KE6QMDand Jordi Puig-Suari
- *CubeSat-One Kilogram of Technical Challenge*, Cliff Buttschardt, K7RR
- *Amateur Radio Packages on OS-II*, Randolph Kohlwey, N7SFI
- *So You Want to Build a Satellite*, Dick Jansson, WD4FAB
- *Phase V and Beyond*, Dee Interdonato, NB2F

Satellite Operations and Technology

- *Data Reception Rates from Digital Satellites Using Various Antennas, Feedlines, Preamplifiers*, G. Gould Smith WA4SXM
- *Mode V/I Easy-Sats for Everyone*, Bob Bruniga, WB4APR
- *Tricks, Hints, and Tips for a Portable Satellite Operator*, Chuck Duey, KI0AG
- *InstantTune for the FT-100*, Tony Monteiro, AA2TX
- *An APRS Satellite for Mobile/Handheld Communications*, Bob Bruninga, WD4APR
- *The Houston AMSAT Net*, Bruce Paige, KK5DO
- *APRS and the TAPR Easy Track® Az/El Rotor Control System*, Keith Sproul, WU2Z
- *The New G3RUH Software Modem for the DSP56002EVM*, Borja Etxebarria, Itziar Martinez, Txema Rúa and Inma Hernáez
- *Recent Developments in the GPS World*, Tom Clark, W3IWI
- *Distributed Processing Goes Galactic*, Paul Shuch, N6TX
- *Estimating Keplerian Elements for New Satellite Launches*, Ken Ernandes, N2WWD

Symposium hosts George W1ME and Carolyn WA1MER Caswell accept an appreciation of thanks for their outstanding efforts from AMSAT President Keith Baker, KB1SF. (photo Art Feller, W4ART)

For those who could not attend the Portland meeting, Bruce Paige, KK5DO collected over 56 Mb of symposium audio files of presentations that are now available for listening or downloading via *www.amsatnet.com*. Thanks to Eric Cottrell, WB1HBU for providing the sound board and computer for doing the encoding during the symposium.

The Annual Banquet held on Saturday evening was a success. R. Cargill Hall, Chief Historian of the National Reconnaissance Office gave a fascinating presentation on the history of spy satellites. Numerous awards were presented to AMSAT members for their contributions during the past year (Table 1). Many participants took home prizes that were donated by many generous sponsors (Table 2). Grand prize winners were: Barry Baines, WD4ASW: Kenwood TMD 700A; Gilbert Mackall, N3RZN: Alinco DJ V5 HT; Rodney Scribner, KA1RFD: Icom Handheld IC T7H; and Ken Nichols, KD3VK: 35 percent discount on Yaesu purchase.

Also, Bill, WB6LLO and Leanore, KA6UCD Guimont announced the winner of the Annual Jewelry Contest. This year there were a total of 91 entries which was the biggest response ever. The *measured* frequency of the Tuney-Tuna was 145.925821 MHz after adding three decimal places to preclude a tie. The winner was Anthony Monteiro, AA2TX with his entry of 145.925426 MHz. The second *eyeball dip-meter* was Bill Tynan, W3XO with 145.923567 MHz. The third was Harley, K6DS, with 145.896233 MHz and fourth was Cliff Buttschardt, K7RR, with 145.765000 MHz.

At the banquet, Bill and Leanore announced their retirement from the Annual Jewelry Contest. While they thoroughly enjoyed it for eight years, they have considered that to be up against *term limits*. Inasmuch, they thank everyone, participants and supporters, for the spirit in which it was received. Next year, Ken Ernandes, N2WWD is taking over the reins of this contest.

On Sunday morning, an Area Coordinator's Breakfast was held in which numerous ideas on promoting Phase 3D/AO-40 and ARISS to the Amateur Radio community were discussed. In addition, a CD ROM was distributed that provides Area Coordinator's with a variety of information and presentations.

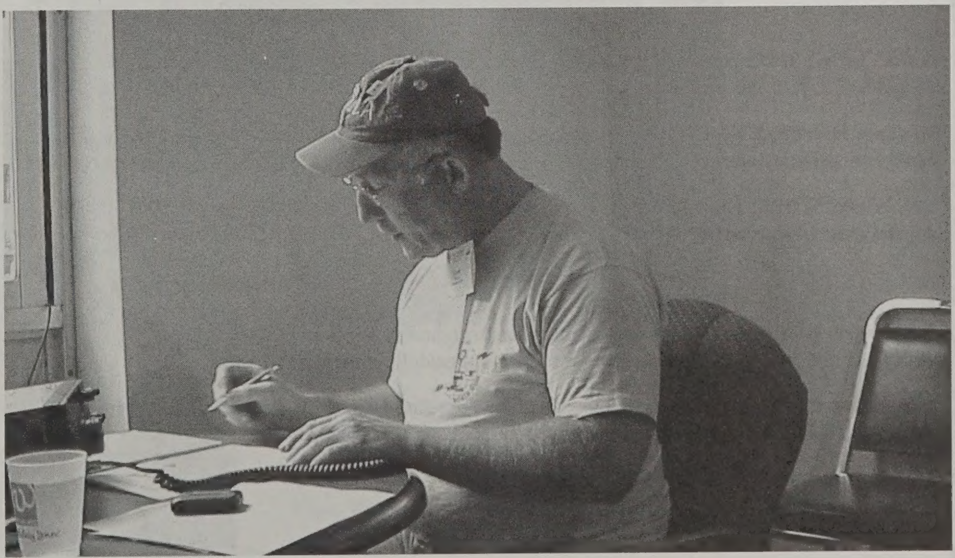
Later that morning, over 30 participants attended an AMSAT Strategy Session Workshop hosted by the AMSAT Strategy Team. The objective of this workshop was to obtain member's input on what future direction AMSAT needs to take once in an AO-40 and ARISS operating environment. Results of this workshop will be published in an upcoming issue of *The AMSAT Journal*.

On Sunday afternoon, a meeting of the AMSAT Board of Directors began. At the meeting, Robin Haighton, VE3FRH was named AMSAT President while Ray Sofier, W2RS was named Executive Vice President. Former President Keith Baker, KB1SF was named Immediate Past President. Afterwards, a variety of AMSAT business was conducted, the minutes which will be reported in the next issue of *The AMSAT Journal*.

At the banquet, Keith Baker, KB1SF reported that the 19th AMSAT Annual Meeting and Space Symposium will be held in Atlanta, Georgia. Steve Diggs, W4EPI will be hosting this event scheduled for 5-7 October 2001 at the Holiday Inn Select in Decatur, GA. Stay tuned to ANS and *The AMSAT Journal* for additional details of this event. See you in Atlanta! ■

Leanore Guimont, KA1UCD and Anthony Monterio, AA2TX, winner of the Annual Jewelry Contest (photo by Art Feller, W4ART).

Steve Diggs, W4EPI inviting all members to attend the 19th AMSAT Annual Meeting and Space Symposium to be held in Atlanta, Georgia on 5-7 October 2001. (photo by Art Feller, W4ART)



Ernest MacLauchlan, K1ELA at W3ZM special event station. (photo by Dave Guimont, WB6LLO)

AMSAT Symposium Awards

George Caswell, W1ME & Caroline Caswell, WA1MER: In grateful appreciation for serving as our gracious hosts for the Year 2000 AMSAT-NA Annual Meeting and Space Symposium in Portland Maine. Your dedicated service, boundless energy, and just plain hard work in coordinating the myriad details of our annual AMSAT gathering is noted and very much appreciated.

David Feeney, WN1F: In appreciation of your help in hosting the AMSAT Symposium, for your willingness to do any job and especially for your work with youth, the future of Amateur Radio and AMSAT.

Communications and Information

AMSAT-ZL: To AMSAT-ZL for the development of AMSAT-ZL Satellite Compendium CD ROM and the donation of the AMSAT-NA proceeds to the Phase 3D fund. Our sincere thanks for your continued, strong support.

Terry Douds, WB8CKI: You are recognized for your involvement in the production of the AMSAT-ZL CD ROM for North American distribution. Your generous support and timely response in making CD ROM copies for AMSAT-NA members use is greatly appreciated as it allowed for wide dissemination of diverse and detailed amateur satellite information.

Steve Ford, WB8IMY: In recognition of the many excellent articles on amateur satellites and satellite operations in the pages of QST.

Ray Hoad, WA5QGD: For faithful service every week putting out the AMSAT Keplerian data as AMSAT's Orbital Data Manager.

Jim Randall, N3YDT: You are recognized for your efforts in developing *The AMSAT Journal* CD ROM. The long hours that you devoted to producing this CD ROM, and your persistent efforts in spearheading this project are greatly appreciated as they allow members to maintain an invaluable detailed technical record of AMSAT accomplishments.

Net Operations Awards

Larry Brown, W7LB: In recognition of untiring service each week on the 20 meter AMSAT International Net and for representing AMSAT at many Hamfests and gatherings.

David Eid, KC8BRL: In recognition of your significant efforts as a member of the Houston AMSAT net team by hosting the web site WWW.AMSATNET.COM. Its carrying, live, of the Houston AMSAT Net and associated presentation of data and Real Audio files have proved to be a major factor in promoting AMSAT and distributing amateur satellite information throughout the world, especially to those who do not have access to local or regional nets or the ability to receive geostationary satellites. Through AMSATNET.COM, anyone with access to the Internet has a means of keeping up with AMSAT activities and related information pertaining to the amateur satellite program. AMSAT gratefully acknowledges the presence of this valuable service and looks forward to its continuation. Thank you very much for your role in this worthwhile activity.

Ernest MacLauchlan, K1ELA: In appreciation of your faithfulness in promoting AMSAT through your weekly net on 146.640 MHz. The *Heavy Hitters AMSAT Net* with you in control, has introduced a large number of hams to satellite operation. In addition, your presence at the ARRL New England conventions has been beneficial to AMSAT and is most appreciated.

Mahana Paige, W5BTS: In recognition of your efforts as a member of the Houston AMSAT Net Team. The results have been significant. The Houston AMSAT net with its emphasis on AMSAT News Service information has been heard around the world via short-wave broadcasts, direct satellite feeds, North American VHF and UHF repeaters and Real Audio on the Internet. AMSAT looks forward to your further contributions and successes.

Russ Platt, WJ9F: For excellent service in keeping AO-16 alive as the AO-16 command station during a year when AO-16 has developed problems.

Al Tribble, W3STW: For the hard work in keeping the AMSAT East Coast 75 Meter net alive under difficult circumstances.

Wray Dudley, W8GQW: To *The Grand Old Man of the AMSAT HF Nets* for many years of dedicated service to the HF nets.

Phase 3D Awards

AMSAT-UK: In recognition of the contributions of AMSAT-UK to the Phase 3D Project including raising over $100,000 in essential funding. The strong support of AMSAT-UK to this project is sincerely appreciated.

Graham Ratcliff, VK5AGR: In recognition of four years of devoted service to the satellite community as IARU/Satellite Frequency Coordinator, your many years as a satellite command station and SAREX telebridge station. Your hard work and effort in these activities is most appreciated.

Jim White, WD0E: For guidance and support of several university satellite projects, while also leading the Microsat command team and participating in the development of the Phase 3D digital operations.

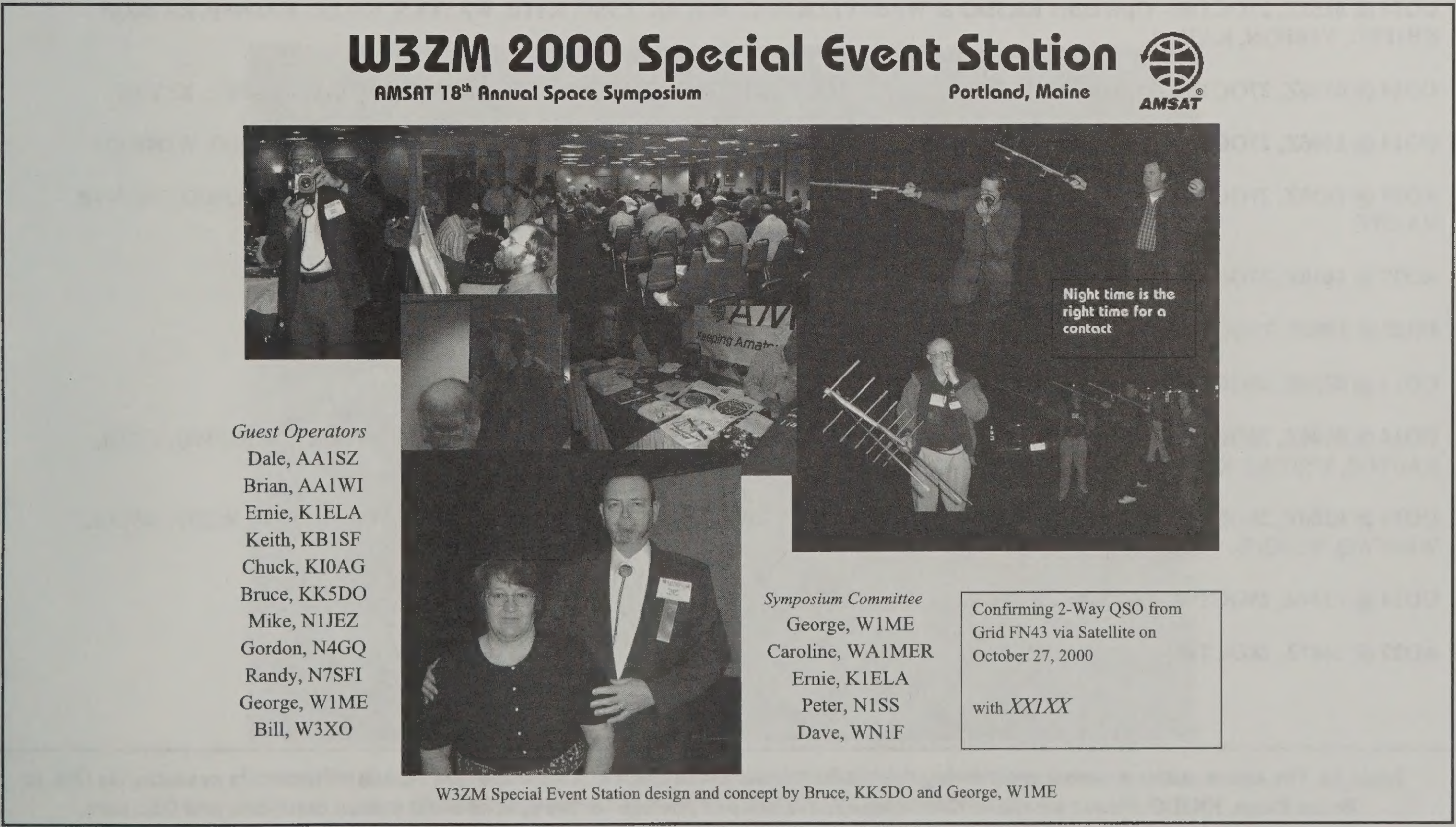
Satellite Operations

Ray Soifer, W2RS: For sponsoring the popular *Straight Key Night on OSCARs* each new year for many years, for his dedication to operation on the Easy Sats with as simple a radio as possible and for publishing guidelines for using the Easy Sats.

The Huntsville Amateur Radio Club, K4BFT: First Place Finish in the 2000 Radio Amateur Satellite Corporation Field Day event on June 24th and 25th operating ARRL class 5A with emergency power and portable operation.

Table 1. AMSAT Awards. (Please see Field Ops article on page 19 for additional awards.)

AMSAT President Keith Baker, KB1SF congratulates grand prize winners. Top left photo, Barry Baines, WD4ASW with Kenwood TMD 700A; top right photo, Gilbert Mackall, N3RZN with Alinco DJ V5 HT; and bottom left photo, Rodney Scribner, KA1RFD with ICOM Handheld IC T7H; bottom right photo Ken Nichols, KD3VK with 35 percent discount on Yaesu purchase. Thanks to all sponsors for donating these gifts! (photos by Art Feller, W4ART).



W3ZM 2000 Special Event Station

AMSAT 18th Annual Space Symposium **Portland, Maine**

AMSAT
Night time is the right time for a contact
Keeping Amat

Guest Operators
Dale, AA1SZ
Brian, AA1WI
Ernie, K1ELA
Keith, KB1SF
Chuck, KI0AG
Bruce, KK5DO
Mike, N1JEZ
Gordon, N4GQ
Randy, N7SFI
George, W1ME
Bill, W3XO

Symposium Committee
George, W1ME
Caroline, WA1MER
Ernie, K1ELA
Peter, N1SS
Dave, WN1F

Confirming 2-Way QSO from
Grid FN43 via Satellite on
October 27, 2000

with *XX1XX*

W3ZM Special Event Station design and concept by Bruce, KK5DO and George, W1ME

Many thanks to all of the following sponsors for donating prizes for the Annual Banquet

Grand Prizes

Kenwood: TMD 700 Transceiver

ICOM: Handheld IC T7H

Alinco: DJ V5 HT

Yaesu: 35 percent discount on purchase

Prizes

Advanced Receiver Research: Preamp SP144VDG

AMSAT: Nova for Windows

American Radio Relay League: 2001 Handbook

American Radio Relay League: Operating Manual

Arrow Antenna: Arrow Antenna

DeLorme: Earthmate GPS Receiver

M2: EB432 w/RK70cm Antenna

OSCAR Satellite Report: One-year subscription (2)

Premier Communications Corp.: AL-800 Antenna (5)

SSB Electronic: 25 meters of Aircom Plus

Wireman: 132 feet of RG8x Iia

Amateur Radio Trader: One-year subscription

American Radio Relay League: QEX Subscription (2)

American Radio Relay League: Antenna Handbook

American Radio Relay League: UHF/Microwave Manual

CQ Communications, Inc.: CQ Subscriptions (2)

HRO: ARRL Satellite Anthology (2)

M2: EB144 w/RK2m Antenna

PC Electronics: $50 Gift Certificate

Spectrum International: Uni-Trac 2000

SSB Electronic: N Connectors for Aircom Plus (2)

World Radio: World Radio subscriptions (6)

Table 2. AMSAT Annual Prize Donors

Satellite Loggings

UO14 @ 0153Z, 27OCT00 - Operators KK5DO & WA6NVL: KI0AG, W9CRK, K9SG, K4TB, WA5VKS, N5LUL, KA0BFP, KA2KQP, KB1FRU, VE6EGN, KA3RFI

UO14 @ 0330Z, 27OCT00 - Operator KK5DO: KC7QFS, N5ZNL, XE1GRR, W7JPI, WD5GXX, N5AFV, N7QBZ, VE5SWL, K5VAS

UO14 @ 1406Z, 27OCT00 - Operator KB1SF: VA3BZD, VE6EGN, K1LO, WD4WXU, W2RS, WB4FWQ, FM1DQ, W4?PG, WD4RXU

AO27 @ 1430Z, 27OCT00 - Operator KI0AG: KC0EEQ, N8XKZ, KG4JAR, WB1ZZU, WB4FWQ, W5GDC, VE4TV, VA3BJD, VE3NVP, VA3SPC

AO27 @ 1616Z, 27OCT00 - Operator KI0AG: K6YK

FO20 @ 1900Z, 27OCT00 - Operator KI0AG: W7JPI, AA9LC

UO14 @ 0050Z, 28OCT00 - Operator KK5DO: WB2RXF, VE2IU

UO14 @ 0140Z, 28OCT00 - Operator KI0AG: WA2HKS, KB1SF, VE3SPC, KB1FRU, FM1DQ, KK5DO, WA6NVL, WB4FWQ, ??ZUI, KA0YOS, VE3TZQ, KF4ABP

UO14 @ 0300Z, 28OCT00 - Operator KI0AG: WA4ZJJ, K4WBM, K5OE, ^K5E, W4MZM, KA0YOS, N9URR, W5ADC, WZ0Y, N5LUL, WB4FWQ, KC7QFS, VE5SWL, VE5TZQ

UO14 @ 1334Z, 28OCT00 - Operator: KI0AG: KA2KCT, WA5VKS, WA2HHS,

AO27 @ 1447Z, 28OCT00 - Operator KI0AG: KK5YY, W6ZQ

(continued on page 9)

Table 3a. The above stations were logged during the W3ZM Special Event Station. A special event station certificate is available via QSL to Bruce Paige, KK5DO. Please send a 9x12 envelope with 2 units of postage for the special event station certificate and QSL card.

HF Log: All 10m Unless Noted

27OCT00 - Operator K1ELA: 1300Z: N0VAO, W5GT, KC0GDN, N5DAD, DC5WH, DH5AO, K0CIY, IZ2BKA, KJ5JR 1400Z: DH3NAW, DF4PR, UX0ZZ, G3ZUC, G3NHL, N0FFO, N5JGK, G4BLH, G4YBI, W2GPS, N9AI, AC5ZU, PA1XA 1500Z: N0WJU, DL6FD, K7NN, G3YEC, I1POR, N1AO, ON4ED, N1UDH, OE3DSA, G3KGN, KI5FJ, IK2OPZ, G4DYC, IZ1DSH, OK1TFH 1600Z: G4RIO, OK1AA, G0VXD, G0WVT, M0CQL, W0MGI, G3CMU, DG2DWP, N4KTS, DH0MWH, DL1AAH, WB5ZNV, AA0XG, I4YMO, IV3EHH 1800Z: KR4JZ, W0MTW, K2UGH, M0CJY, GM0VXA, EA8DO, WB2FKR

1800Z - Operator W1ME: WA2N??

28OCT00

0700Z - Operator W1ME: PI4CC

1400Z - Operator AA1SZ: W9LD 20m, KD1RC 20m, RW2F 20m,

Operator K1ELA: KB9TYU, GI3KDR

1600Z - Operator W3XO: W2GPS 1700Z: IK3IX

1800Z -Operator N4GQ: CN8WW, 9A5AZZ, CT1AOZ Operator AA1WI: OZ5ESB, F6KRC, IY4W, EB7ED, S58D 1900Z: F6BEE, M4U, OE2S, RW2F, K5DQ, F5KQN

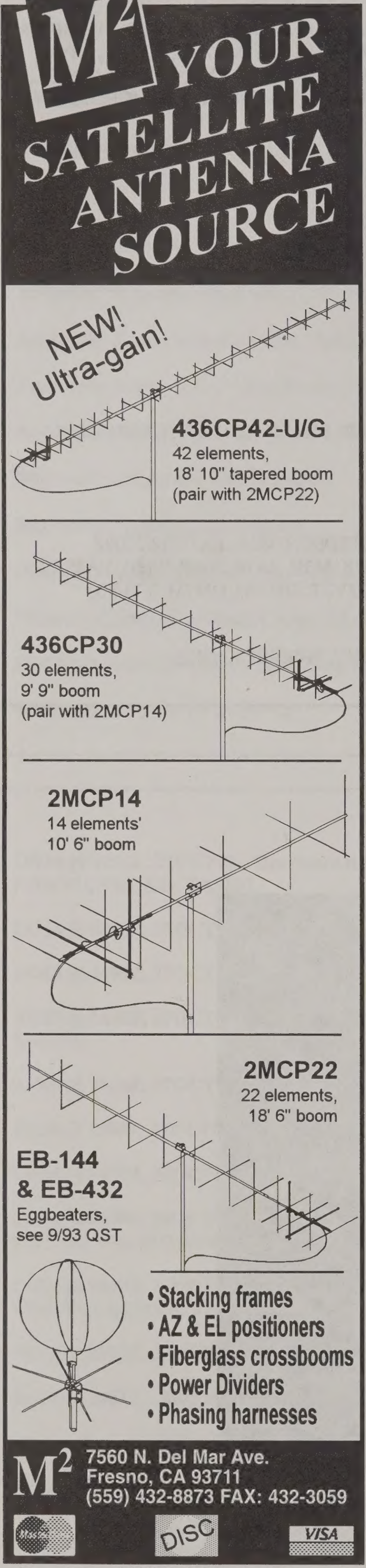
2000Z - Operator N4QQ: OH2RA, HG1R, O25W

Operator N1JEZ (All Contacts on 15m) 1900Z: F5KQN, ZB2X, GW4BLE, N8NR, IK5ZTW, UT5UGR, CT1DSC, OM1A, EA1COZ 2000Z: OH5BM, EA1EEY, WB9Z 2100Z: OH2BH, EA8AH, SN8V, 9A6A, OZ5ESB, S51SL, UZ5I, LY7Z, EA1UX, M3G, 9A7A, IH9P, 9A3B, VA3SK, DL4NAC, IU2D, DJ7AA, OT0A, HG0HQ, OM8A, K3ZO, N5YA, OH1JD, CN8WW, NX5M, OH6NIO, G3VZT, DF0HQ, OM7M, YT1BB, EA4URE, YU1JW, OL5Q, EA1COZ 2200Z: 1G9A, OH8L, IQ4A, EA1EEY,

29OCT00 - Operator W5IU:1800Z - 20m: N1KFC/4, WC8I, NY3EC, W8ANN, W5UUX, W8ANN, KB3DUV, W4EWB, K8OHZ,

Table 3b. W3ZM Special Event Station Log Concluded.

Txema Rúa (l) and Itziar Martinez (r) came all the way from Spain to present their paper on a new G3RUH software modem. (photo by Dave Guimont, WB6LLO)



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18' 10" tapered boom
(pair with 2MCP22)

436CP30
30 elements,
9' 9" boom
(pair with 2MCP14)

2MCP14
14 elements'
10' 6" boom

2MCP22
22 elements,
18' 6" boom

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- AZ & EL positioners
- Fiberglass crossbooms
- Power Dividers
- Phasing harnesses

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DISC VISA

APRS at Portland

Bob Bruninga, WB4APR

The locals in Portland, Maine were surely entertained with the sight of a dozen antenna waving satellite techies in the parking lot at the Holiday Inn at all hours of the day and night. But this year's AMSAT-NA gathering had a new wrinkle. There was a copy of APRSdata.exe running on a laptop in the hotel which transmitted throughout the area on 144.390 MHz providing the location, distance, bearing, direction of movement, up & down frequencies *and* Doppler of any amateur satellite in view, plus the schedule of all satellites expected to pass during the next 80 minutes. All of this information was viewable on the front panels of any Kenwood D7 HT, D700 Mobile rig, or any other handheld APRS display device. Thus, none of the users ever had to consult any tracking programs, but simply glance at their radios occasionally to be alerted to any interesting passes. Everything they needed was there.

Prior to arrival, I had been concerned that there was no existing 144.390 MHz APRS infrastructure within 50 miles of Portland. But as soon as the first APRS mobile arrived in town, the additional arrivals all found the APRS frequency alive and well. I was even able to report my position from the baggage claim area at the airport by digipeating off of a mobile station somewhere nearby. Eventually, at least 18 stations appeared at the conference with either a D7 in their hand or a D700 in the parking lot.

Such an isolated, yet grass-roots APRS network was *perfect*. The only thing on our radio panels was us and there was no out-of-area QRM causing any distractions. We even switched APRSdata.exe into high gear to announce every satellite, not just the FM birds and throughout the conference, every HT, and every Radio had up-to-date satellite tracking information on their front panels that they could then use to go out to the parking lot to do their passes. Using a simple scanner with SSB, we even heard a FO20 pass loud and clear on a whip antenna.

During a coffee break, someone suggested that the D700 with voice chip could even speak the satellite passes and within an hour or so I added it to APRSdata.exe so that these D700's would speak the following three types of statements:

- **AO27 LOW:** When the satellite came above 5 deg.
- **UO14 MEDIUM:** When the satellite rose above 15 deg.
- **SO35 HIGH:** When the satellite rose above 30 deg.

Some AMSAT members expressed an interest in setting up an APRSdata server in their area, so when I got home, I updated the following web page to help describe it: *http://web.usna.navy.mil/~bruninga/satinfo.html*

Looking at my HT, I had captured the following while at the conference hotel. N8NUY operated his Mobile DIGI for new arrivals at the Airport and W4HFZ and WB4GCS represented the Navy contingent. KB2WQM operated UO22, SO35, and the pacsats while WA6NVL, N3ZLL, KA2QYE, N2POR, KI0AG, KA1CQD, WB1HBU, WD5DZC and W3ADO kept the APRS channel busy, so there was always something going on. We also had the usual messages from the back of the room via K5NRK!

Lots of fun!

de WB4APR, Bob ■

Make Plans to Attend the
19th AMSAT Annual Meeting and Space Symposium
to be held
5-7 October 2001 in Atlanta (Decatur), Georgia

WWW page and Journal information is forthcoming from Symposium Chair Steve Diggs, W4EPI

A Summary of the Conference on Small Satellites

Randolph Kohlwey, N7SFI

The Fourteenth Annual AIAA/Utah State University Conference on Small Satellites was held in Logan, Utah during August 2000. The theme of the conference was *Small Satellites in Triumph and Tribulation: A Year of Paradoxes*. Papers were presented on past and future missions. Additional papers were on new technology and methods being applied in small satellite development. Over 60 companies and 8 universities had exhibits at the conference. Several featured amateur satellites. This article presents highlights from the papers and presentations that may be of interest to members of AMSAT.

JAWSAT Mission

One of the first papers (I-1) presented was on the January JAWSAT launch that placed AO-37, OO-38 and WO-39 into orbit. The paper was presented by Scott Schoneman of Orbital Sciences Corporation and Major Steven J. Buckley. The first Minotaur launch achieved all of its mission objectives including putting the 11 satellites into the desired orbit. It was 48 months from the start of the program to the launch. In this time there were several changes of payloads. The last major change was made 14 months before the launch. That was when OPAL (OO-38) with its picosats and ASUSat1 (AO-37) were offered a ride.

According to Orbital the launch vehicle performed as expected as shown by the telemetry received before the stage 3 separation. Telemetry was not received for stage 4 and very limited data was extracted from the booster when it passed over the McMurdo, Antarctica ground station. That telemetry showed that the 4th stage was operating nominally and that the payloads had separated. The paper included plots showing the measured environmental conditions better than the predictions.

Major Buckley presented the payload part of the paper. As the Air Force Payload Manager he rated each of the payloads with a percentage of success. He gave the Softride System a 100 percent rating. This system isolated the payloads from the rest of the launch vehicle. It worked to reduce the vibration and shock the satellites experienced during launch. Opal was given a 100 percent evaluation since it is still working and successfully deployed the picosats. The Optical Calibration Sphere OCS was also given a 100 percent score. He enjoyed seeing it in space from his backyard days after the launch! ASUSat and Falconsat were each given 75 percent evaluation since they only operated for a short time. The JAWSAT payload was given 50 percent evaluation which was the combination of 100 percent for the Multi-Payload Adapter (MPA) and 0 percent for the Attitude Control Platform (ACP). The other satellites were mounted to and deployed from the MPA platform. The ACP was rated low because he had not yet received a failure analysis report.

Other Minotaur Launches

The second launch of the Minotaur occurred in July of 2000 which put the MightySat-II satellite into space. Another paper (I-2) reported that the satellite is performing very well. This leaves three more sets of Minuteman II rockets that the Air Force has been given permission to use in future Minotaur launches. Any satellite using these launches must have a US government sponsorship.

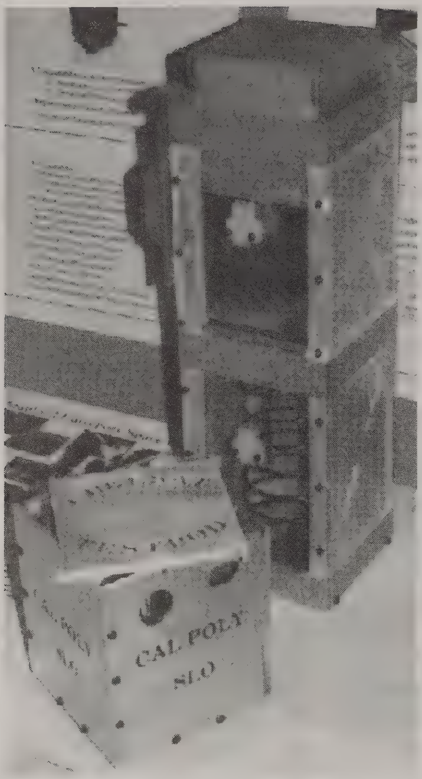
JAWSAT

A paper (V-4) presented by Jay Smith of OSSS and CAST reviewed the JAWSAT mission. One Stop Satellite Solutions (OSSS) is the company that did the payload integration. The Center for Aerospace Technology (CAST) at Weber State University was responsible for the amateur radio package on the JAWSAT satellite (WO-39).

The Joint Air Force Academy/Weber University Satellite (JAWSAT) mission changed several times over its lifetime that began in 1994. It started as a purely academic student project with cadets from the academy and students from Weber State. The second major change occurred in 1995 when it became an Air Force science mission to fly on the Orbital-Suborbital Program (OSP). This is when it was given a launch slot on what became the Minotaur. That mission was completed through a successful Critical Design Review but the day before the final contract was to be let the DoD recalled all non-committed funds. The final mission was resurrected in April of 1998 when the university, NASA and Air Force Research Laboratory payloads were added.

The Weber State University Attitude Controlled Platform (ACP) included a 3-Axis attitude control system and a command and control communications system. The system included two 2 meter FM receivers, two 70cm FM transmitters and one S-band transmitter all coordinated for frequencies in the Amateur Radio satellite bands. Signals were heard from both UHF transmitters on the first orbit. There was some indication that at least one of the receivers was working. The S-band transmitter was never turned on. Attempts

Stanford University professor Robert Twiggs, KE6QMD loading a CubeSat into a launcher designed at California Polytechnic State University.



A prototype Poly Picosatellite Orbital Deployer (P-POD) CubeSat launcher and a TestPod where shown in the University Student Exhibit.

throughout the summer to reset the satellite were unsuccessful.

The four independent satellites were held and deployed by the Multi Payload Adapter (MPA). The deployment signals from the launch vehicle were passed through the MPA to each individual satellite. All indications show successful deployments.

One serious issue that occurred in November of 1999 was the fact that the mass was over budget. It was determined that the payloads that were too heavy could not be lightened without removing major portions of their mission.

This problem was solved with the cooperation of several of the other payloads. The Optical Calibration Sphere gave up some of its expected lifetime by removing some of the ballast. The Air Force changed one of Falconsat's steel separation rings to an aluminum alloy. They also offered their deployment battery for use by JAWSAT after they separated. A 12-pound secondary battery was removed from Weber State's ACP and the ability to use the Air Force deployment battery was added. The above changes reduced the mass back to 430 pounds.

Since the presenter of the paper is also a professor at Weber State University he felt obliged to give grades to the mission. He gave the launch vehicle an A, the integration an A, and the ACP an incomplete. Another ACP is being readied for another flight in 2001 for a make up grade.

ASUSat-1

A paper (V-2) was presented on the ASUSat1 satellite. This project involved over 400 students working over a 6-year period. Over its 14-hour life there were 11 contacts made with the satellite by amateurs around the world. This satellite had a VHF 2m uplink and a 70cm downlink. The command link used digital AX25 9600 baud FSK. It could also have been configured as a FM repeater. The digital side had priority so a beacon would have interrupted any QSO in progress.

The team was able to collect useful data that verified much of the operation of the satellite. All of the data was as expected except for the battery charging indicator and the fact that the battery voltage continued to drop.

The first telemetry received from the satellite showed that the battery voltage was 7.36 volts and the last telemetry packet showed it at 7.02 volts. Every telemetry packet received indicated zero charging of the battery. Power budget calculations estimated that the satellite could run on battery power alone for 15 hours.

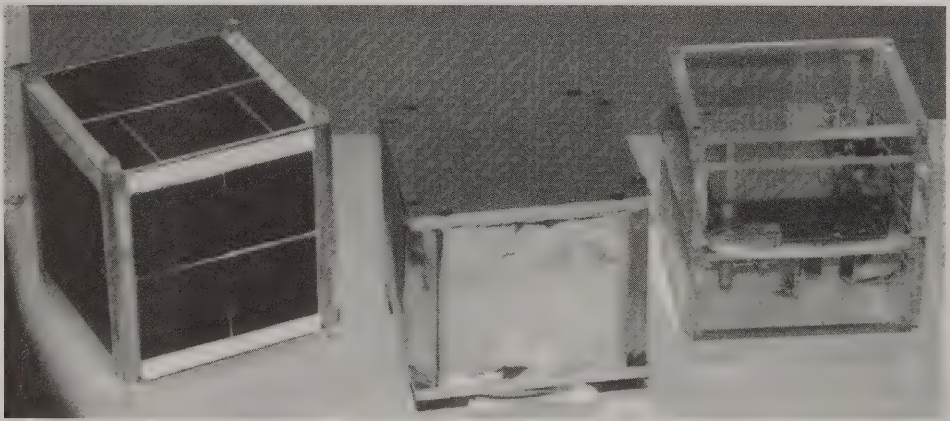
The paper included a log of the events of the first 14 hours. Included in this were the Amateur Radio operators who reported hearing and/or receiving its downlink. Included were Paul Roos, ZS6HQ; Niki Steenkamp and Dirk van der Merwe from the SUNSAT team, Ian Ashley, ZL1AOX; Randy Kohlwey, N7SFI; and Steve Diggs, W4EPI. The last telemetry packet was received by the South African SUNSAT team on 27 January 2000 at 16:48:52 UTC on the satellite's ninth orbit. A formal failure analysis was done but no specific problem was identified.

The experience they gained from the ASUSat-1 project was enormous and is being used in future projects at Arizona State University in their current satellite projects. The satellite did prove that a 6-kg satellite is a viable spacecraft for a serious mission. They explained the AMSAT-NA requirements needed to obtain their AO-37 OSCAR designation.

OPAL

The Orbiting Automated Picosat Launcher (OPAL) was started in April of 1995 and is Stanford's second student built satellite. OPAL was featured in several papers presented at the conference.

One paper (VII-4) on OPAL was presented in the Student Scholarship Competition by Jamie Cutler, KF6RFX and Greg Hutchins, KF6YCR. The OPAL project objectives were to improve their satellite manufacturing capabilities, provide student education and to conduct satellite experiments. The satellite was completely built by students.



Mockups of three CubeSats were displayed in the University Student Exhibit.

The satellite included three major payloads. The first was the *Mothership/Daughtership* test bed. This was the picosat launcher. The other two payloads were test beds for magnetometers and accelerometers. These two experiments are checking on the effects of these devices being exposed to the space environment.

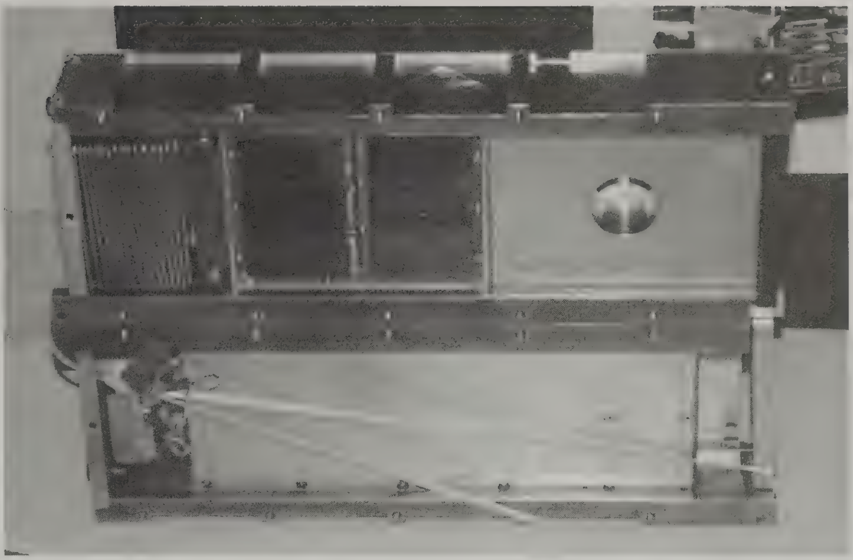
The first payload deployed the six picosats. The first ones deployed were the picosats built by Aerospace Corporation. These satellites were connected by a 10-foot tether and ran on batteries alone. Aerospace was able to check the operation of an array of MEMS (micro electromechanical systems) RF switches before the batteries ran down. They lost power before they were able to complete the spread spectrum experiment. These were the only non-amateur radio picosats deployed. These two satellites were deployed on 06 February 2000.

The picosats that were deployed on 10 February 2000 were the STENSAT and JAK picosats. The STENSAT was built by a group of Amateur Radio operators in the Washington, DC area. It was the only picosat that had solar cells so it could recharge its batteries. The paper reported that no confirmed contacts were made with STENSAT.

The JAK was a simple beacon satellite built by students at Santa Clara University. Once again the paper reported that no confirmed signals were heard. The signals that were reported they believe came from OPAL and not JAK. The batteries on JAK should have run down before 13 February 2000.

The last two picosats (Thelma and Louise) to be deployed were also built at Santa Clara University. They contained a VLF (0.2 -11 kHz) receiver to study the emissions from thunderstorms. They were deployed on 12 February 2000 and possible signals were heard and not confirmed. No lightning data was downloaded.

OPAL's command data link is half duplex 9600 baud FSK on 70cm AX.25 packets using an E.F. Johnson radio. The first full contact with the satellite was made by Jean-Louis Rault, F6AGR from Paris, France. The SSDL ground station was having problems at the beginning of the mission. Amateur Radio operators world wide were given credit for capturing data from OPAL and passing it on to the command station.



A PicoSat launcher containing a model PicoSat and dummy masses was displayed in the University Student Exhibit. This launcher is similar to the one flown on the OPAL (OO-38) satellite.

Operations are now supported by the SSDL ground station which is linked to the Internet. In fact, most of the commanding is now done over the Internet remotely. Another paper (IX-4) presented the work at SSDL on Internet-Base operations.

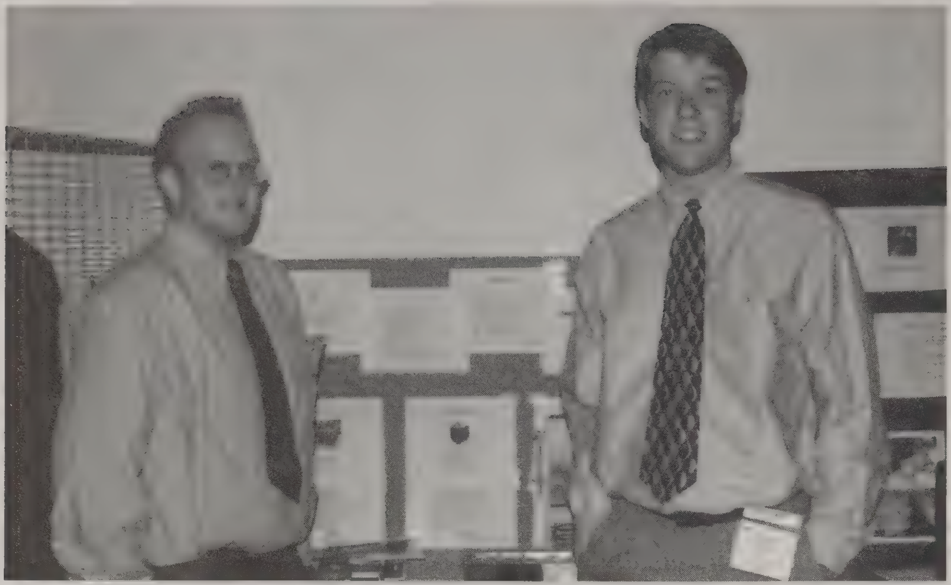
The paper has a section on lessons learned. One was that by using the AX.25 packet radio protocol they gained a worldwide tracking network. Another was that their beacon transmissions were too short making it hard to find. The importance of planning and practicing flight operations was also discovered.

The presentation was concluded by showing data obtained from an OPAL pass over the SSDL ground station that occurred during their talk. One of them was busy commanding the satellite from a laptop connected to the Internet while the other was presenting the paper.

Ariane 5

A paper (I-7) was presented on a pair of UK Defense satellites that will be *piggy-backed* on the same Ariane 5-135 launch as Phase 3D. They showed a photo of the two small satellites mounted on a ring called ASAP that surrounds the Static Bearing Structure (SBS) that Phase 3D was contained in. This is just the opposite of the Ariane 4 launch which contained the *piggy-backed* amateur satellites (AO-16, DO-17, WO-18, LO-19,

The 14th annual Conference on Small Satellites was held in Logan, Utah at Utah State University during August 2000.



Jamie Cutler, KF6RFX and Greg Hutchins, KF6YCR of Stanford University spending some time in the University Student Exhibit.

UO-14 and UO-15) around the SPOT-2 commercial payload.

University of Surrey

In the exhibit area Surrey Satellite Technology Limited had a model of UoSAT-12 (UO-36). They were also giving out a sheet that you could cut out and use to assemble your own model of the mini-satellite. Multiple papers were presented on UoSAT-12.

One paper (I-3) was on a method of calibrating its attitude control system. Another (I-8) presented the current Surrey satellites and some of their plans for the future. As part of its description of UoSAT-12 it contained images of Salt Lake City, Utah and the Aswan Dam in Egypt. It also noted that an IP stack was ported to the satellite. The Surrey ground station receiver was connected to a low cost IP router. The satellite was then *Pinged* as an active node on the Internet. This experiment was further documented in a later paper (IX-1). Surrey Nanosatellite Applications Platform (SNAP) was also described as having a VHF receiver and a S-Band downlink. It has been reported that the downlink is a 38k4 BPSK signal on 2430 MHz.

Robert Twiggs, KE6QMD, a professor at Stanford University, is holding a model CubeSat as he describes a new generation of picosatelles.

Several papers were presented on SNAP-1. Its propulsion system was described in I-3. To reduce size and cost the butane fuel is stored in pipe work and not a tank. Another paper (III-6) describes its CMOS video camera vision system. This system uses a software frame grabber. The video signals are digitized into SRAM and then processed by a 220 MHz StrongARM processor. A separate paper (VIII-8) adds additional information about its 3-axis attitude control system.

Surrey also has plans to go beyond LEO. The MoonShine Mission is described (II-8) as a low cost plan to reach the Moon. Its communications will consist of a dual redundant S-band receiver and transmitter. The transmitter will have a 4W RF output using Viterbi coding to support a 10 kbps downlink. Using a 3.5 meter dish on the ground will give a 3 dB link margin.

Stanford University

In the university student exhibit the Space System Development Lab (SSDL) displayed the PicoSat launcher similar to the one that was used in OPAL (OO-38). A new CubeSat launcher was shown along with some model CubeSats. Papers were presented on these and some of the labs other future projects.

CubeSat

Professor Robert Twiggs, KE6QMD of Stanford University presented a paper (V-5) devoted to the new CubeSat launcher and some of the CubeSats under construction. He displayed the 5 kg Poly Picosatellite Orbital Deployer (P-POD) launcher designed at California Polytechnic Institute that will hold three 4-inch cubed satellites in its 4.5 inch square by 15 inch long volume. It will take a low power activation signal to open the P-POD door to deploy the satellites. In the paper several of the CubeSats under development are described. They must be under 1 kg in mass, fit in a 10 cm cube and must have rub rails that fit the launcher.

The estimated launch cost for each 1 kg or less CubeSat is $30,000 based on a Kosmotras Dnepr launch. Stanford University, Cal Poly and One Stop Satellite Solutions of Ogden, UT are working on arrangements for future Dnepr launches. The Stensat Team is working on one of the CubeSats. Its 2m Amateur Radio band receiver (-100dBm) and transmitter are based on Motorola single chip designs. Both can support data rates up to 9600 baud FSK. The 1/2 watt RF amplifier is based on a RF Microdevices chip.

Students and faculty at the Thayer School of Engineering at Dartmouth College are designing and building the DARTSat CubeSat. The satellite will use 2m and 70cm Amateur Radio frequencies. The satellite receiver uses DTMF for commands and the transmitter sends 9600 bps packets.

The Intelligent Space Systems Laboratory (ISSL) is building the University of Tokyo CUBESAT. The paper did not state if it will use Amateur Radio frequencies. It plans to deploy a membrane that will contain 120 solar cells for a total output of 27.9 Watts.

Cal Poly is also developing the PolySat CubeSat along with the P-POD. It will use a modified Alinco DJ-C4T 440 MHz Amateur Radio HT as a transmitter. It will put out 300 mW RF for a DC input power of 1.11 watts. The command receiver will be based on the MICRF004 data receiver chip from Micrel, Inc. The 209 watt-hours of batteries should provide 150 hours of transmitting time.

Orion

The Orion mission was described (II-4) as a formation flying test bed. The Orion satellite will fly with two other Emerald satellites to demonstrate the use of carrier-phase differential GPS for the coordination of a three-satellite formation. The communication subsystem will consist of two 70cm transmitters, a 70cm receiver and a 2m receiver. The space to ground transmitter will be 2 watts and the space to space transmitters will be 350 mW. The receivers are based on Hamtronics receiver kits.

Canadian MOST Satellite

One paper presented a design based on the MOST satellite. The paper (II-1) on the NESS satellite describes the current MOST design but leaves out any description of the AMSAT LEAST package. The non-amateur portion of the satellite will use two S-Band receivers and two S-Band transmitters. The uplink is 9600 bps and the downlink can be selected between 9600 and 38400 bps.

University/Student Exhibit

Several Amateur Radio satellites were featured in the University/Student exhibits.

Dr. Jeff Ward, G0SUL presented several papers for the Surrey Space Center.

- The Santa Clara University's Intelligent Robotics Program had a poster that includes pictures of the Artemis Picosatellites.
- The Naval Postgraduate School had posters on the Petite Amateur Navy Satellite, PANSAT (PO-34). They also displayed a full-scale model of the satellite.
- The University of Alabama in Huntsville had photos and information on the SEDSat-1 (SO-33) satellite and its mission.
- Stanford University's Space Systems Development Lab had on display a picosat launcher used on OPAL (OO-38). They also showed a CubeSat launcher and model CubeSats.
- The South African University of Stellenbosch had information on SUNSAT (SO-35). They also noted its Amateur Radio operation.
- The University of Arizona had a poster on its UASAT satellite project.

References

Some of the papers may show up on the WWW at: *http://www.sdl.usu.edu/conferences/small*sat/proceedings/14/ If they do not appear via this link, check the following URL for updates on where they can be found: *http://www.xmission.com/~kohlwey/smallsat.html*

Papers

JAWSAT and Minotaur Launch

I-1.pdf - Demonstration of a New Smallsat Launch Vehicle: The Orbital/Suborbital Program (OSP) Space Launch Vehicle Inaugural Mission Results

I-2.pdf - MightySatII: On-Orbit Lab Bench from Air Force Research Laboratory

V-2.pdf - ASUSat1: Low-Cost, Student-Designed Nanosatellite

V-4.pdf - The JAWSAT Mission: Final Report and Lessions Learned

VII-4.pdf - OPAL: Smaller, Simpler, and Just Plain Luckier

Stanford University/Space System Development Lab (SSDL)

II-4.pdf - The Orion Microsatellite Mission: A testbed for Command, Control, and Communications for Formation Fleets.

V-5.pdf - CubeSat: A New Generation of Picosatellite for Education and Industry Low-Cost Space Experimentation.

IX-4.pdf - Infrastructure for Internet-Based Operations

University of Surrey/Surrey Satellite Technology

I-3.pdf - The Design, Development and Testing of a Propulsion System for the SNAP-1 Nanosatellite.

I-4.pdf - In-Orbit Estimation of the Inertia Matrix and Thruster Parameters of UoSAT-12

I-8.pdf - Advancing Small Satellite Earth Observation: Operational Spacecraft, Planned Missions And Future Concepts.

II-8.pdf - Low Cost Planetary Exploration: Surrey Lunar Minisatellite and Interplanetary Platform Missions

III-6.pdf -The SNAP-1 Machine Vision System

VIII-8.pdf - An Attitude Control System and Commissioning Results of the SNAP-1 Nanosatellite

IX-1.pdf - Internet Access to Spacecraft

Ariane 5

I-7.pdf - Countdown to Launch of the First Microsatellites Qualified for Launch on Ariane-5 ASAP

Canadian MOST Satellite

II-1.pdf - NESS: Using a Microsatellite to Search for and Track Satellites and Asteroids. ■

Satellite Orbital Elements

by Ray Hoad, WA5QGD

Satellite	AO-10	UO-14	FO-20	RS-12/13	RS-15	FO-29	AO-27	AO-40
Catalog Number	14129	20437	20480	21089	23439	24278	22825	26609
Epoch Time	335.12259682	335.55605941	334.82052230	335.23120373	334.29012867	335.16798771	335.20902635	335.53803267
Element Set	719	572	272	293	514	375	857	9
Inclination	26.6994	98.3893	99.0749	82.9219	64.8173	98.5681	98.3836	6.3728
RA of Node	298.9084	36.861	74.3701	62.5979	273.4683	221.0881	25.8865	242.6666
Eccentricity	0.6005303	0.0011806	0.0541255	0.00305	0.0167825	0.0351453	0.0008871	0.7346773
Arg of Perigee	105.3477	82.4586	40.3943	24.9638	260.9472	157.2217	128.8309	185.5284
Mean Anomaly	325.2275	277.7987	323.607	335.2992	97.2424	204.4956	231.3667	156.3074
Mean Motion	2.05865026	14.30586452	12.83283224	13.74235851	11.27539508	13.5274962	14.28289983	2.03270179
Decay Rate	0.00000078	0.00000893	-0.00000031	0.00000172	-0.00000042	0.00000098	0.00000672	-0.00000052
Epoch Rev	13134	56665	50652	49248	24412	21173	37417	29
Satellite	**UO-11**	**AO-16**	**DO-17**	**WO-18**	**LO-19**	**UO-22**	**KO-23**	**IO-26**
Catalog Number	14781	20439	20440	20441	20442	21575	22077	22826
Epoch Time	335.18536468	334.75794277	334.74326954	334.92883788	334.71422705	335.19161678	334.91880266	334.71757727
Element Set	359	370	364	393	370	82	995	850
Inclination	98.0036	98.4296	98.4413	98.4403	98.4495	98.1381	66.0889	98.3871
RA of Node	295.5855	43.2808	45.5118	45.3183	46.8735	354.0511	23.3198	26.1204
Eccentricity	0.0010137	0.0011954	0.001199	0.0012528	0.0012856	0.0008569	0.0015454	0.0009462
Arg of Perigee	299.5857	88.7604	86.2817	87.5556	85.5021	61.0321	281.8073	130.3886
Mean Anomaly	60.4347	271.495	273.9741	272.7066	274.7671	299.1725	78.1214	229.8129
Mean Motion	14.73064176	14.30681776	14.30882393	14.30777197	14.30919186	14.37934947	12.8635504	14.28448391
Decay Rate	0.00005101	0.00000835	0.00000995	0.00000766	0.0000083	0.00001149	-0.00000037	0.00000797
Epoch Rev	89673	56656	56661	56663	56664	49177	39003	37413
Satellite	**KO-25**	**TO-31**	**GO-32**	**SO-33**	**PO-34**	**SO-35**	**UO-36**	**AO-37**
Catalog Number	22828	25396	25397	25509	25520	25636	25693	26065
Epoch Time	335.19752762	334.93557746	334.97250286	334.61257245	334.94199701	335.89968221	335.00834926	335.51873640
Element Set	832	436	362	208	247	258	372	99
Inclination	98.3829	98.7048	98.7055	31.4427	28.4579	96.4507	64.561	100.1951
RA of Node	26.7747	48.625	48.3489	44.9158	194.3891	139.5806	324.7587	227.5879
Eccentricity	0.0010416	0.000189	0.0001213	0.0363488	0.0006457	0.0153101	0.0050778	0.0038355
Arg of Perigee	108.6796	339.4732	35.3752	73.4571	240.5984	14.8388	273.409	46.2114
Mean Anomaly	251.5518	20.6377	324.7506	290.565	119.3962	345.723	187.444	314.2233
Mean Motion	14.28864934	14.22840811	14.22505238	14.25267235	15.07057671	14.41592044	14.73544364	14.34406951
Decay Rate	0.00000994	-0.00000044	-0.00000044	0.00001342	0.00006793	0.00001281	-0.00000725	0.00000903
Epoch Rev	34237	12422	12423	10944	11490	9310	8673	4420
Satellite	**OO-38**	**WO-39**	**SAUDISAT-1A**	**TIUNGSAT**	**SAUDISAT-1B**	**OCS**	**MIR**	**ISS**
Catalog Number	26063	26061	26545	26548	26549	26062	16609	25544
Epoch Time	334.73420764	335.55619301	335.52353219	335.54132597	335.49526472	335.77835545	335.83591797	335.77194014
Element Set	100	126	41	33	30	100	270	335
Inclination	100.1956	100.1858	64.5545	64.5503	64.5507	100.2333	51.644	51.5739
RA of Node	226.6513	227.8245	353.0361	352.6248	353.3968	237.0933	124.3324	13.4251
Eccentricity	0.003775	0.0036218	0.0010176	0.0006843	0.0014047	0.0030975	0.0016913	0.0003912
Arg of Perigee	46.8912	43.7361	55.3437	31.7684	72.3939	28.4664	66.0758	258.7998
Mean Anomaly	313.542	316.6672	304.8624	328.3828	287.8703	331.8069	294.2022	101.2571
Mean Motion	14.34470835	14.35116348	14.74675739	14.75851439	14.73771233	14.74515455	15.81140141	15.63549476
Decay Rate	0.0000097	-0.0000124	0.00004062	0.00005353	0.00003864	0.00044707	0.0010744	0.00047004
Epoch Rev	4409	4423	959	960	959	3740	84537	11603

PE1RAH-SAT1

William Leijenaar, PE1RAH

pe1rah@hotmail.com

I have studied the idea of constructing a linear satellite transponder, because today's popular new Amateur Radio satellites often only use FM modes, or the PACSATs digital modes. With a linear transponder you can do more experiments and it is much more fun to have an analog contact in voice, sending SSTV pictures, or RTTY.

I am a student studing telecommunications and as a result, enjoy the electronic design portion of our hobby. My interests are VHF, UHF, and higher frequency space communications such as mode S. After graduation I would like to design space transponders. Since I have already designed and constructed three local FM repeaters, I wanted to take time to learn about making an analog satellite transponder. While I have tried to find some local persons interested in this project, I have not been able to locate any interest at my school. Also, local amateurs do not appear to be interested in such a satellite project. So, I started to do it by my own since I already had some experience designing local FM repeaters. So why not design a satellite transponder?

About one year ago I started this project. I wanted to make a transponder that has little chance to fail once in orbit. For background information, I started to read about failed satellite missions and I paid special attention to the causes of satellite failures. With this information I made the following list of conditions that my transponder had to be capable of performing:

- It must be small in size and weight in order to get an easier position as a secondary payload.
- Its receiver must be sensitive and provide enough output power that it can be easily used.
- It must have good efficiency in using low current (smaller solar batteries means smaller size), and low heat production.
- It must be temperature stable for good radio contacts.
- It must be radiation proof to allow longer lifetime.
- It must be vibration proof to reduce surprises after launch.

Several months ago I developed and constructed a conceptual prototype that after much testing was finally functioning to my specifications (Figure 1). Then with new components I used this conceptual prototype to make design prototype transponder (Figure 2). Once completed, I have tested the design prototype transponder at home by measuring its operating capabilities. Together with my satellite friend Dirk Reyners, ON1DLL, we made numerous QSOs several in modes for long periods of time. As a result, the design and test part has been concluded. For me, this was a project that allowed me to obtain more experience in designing and constructing satellite transponders. The next step is to somehow get this design prototype successfully operating in space for Amateur Radio use. To finish it as a real satellite, I still need to obtain and test solar cells and batteries that can handle space environment. Presently solar cells and space-rated batteries are too expensive for me, but maybe there are others who can help.

In closing, I would like to thank Dirk Reyners, ON1DLL who helped me with testing the design prototype transponder. As you can see, I am very interested in the technical design of satellites, especially V/U/S modes and I am looking for persons that would like to discuss my designs. For further information please see my WWW site: *http://www.qsl.net/pe1rah*

Some Details About the PE1RAH-SAT1Transponder

- **PE1RAH-SAT1** is an Analog Amateur Radio Mode-B Transponder Satellite. (Please note that the frequencies below are suggested frequencies. Prior to launch, all frequencies will be coordinated with the Amateur Radio Satellite Frequency Coordinator.)
- **Uplink:** 435.200 MHz - 435.300 MHz. LSB
- **Downlink**: 145.950 MHz - 145.850 MHz. USB (2 Watts PEP)
- **Beacon**: 145.825 MHz CW
- **Power:** 12 Vdc
- **Connectors**: SMA (small and less likely to disconnect due to vibrations).■

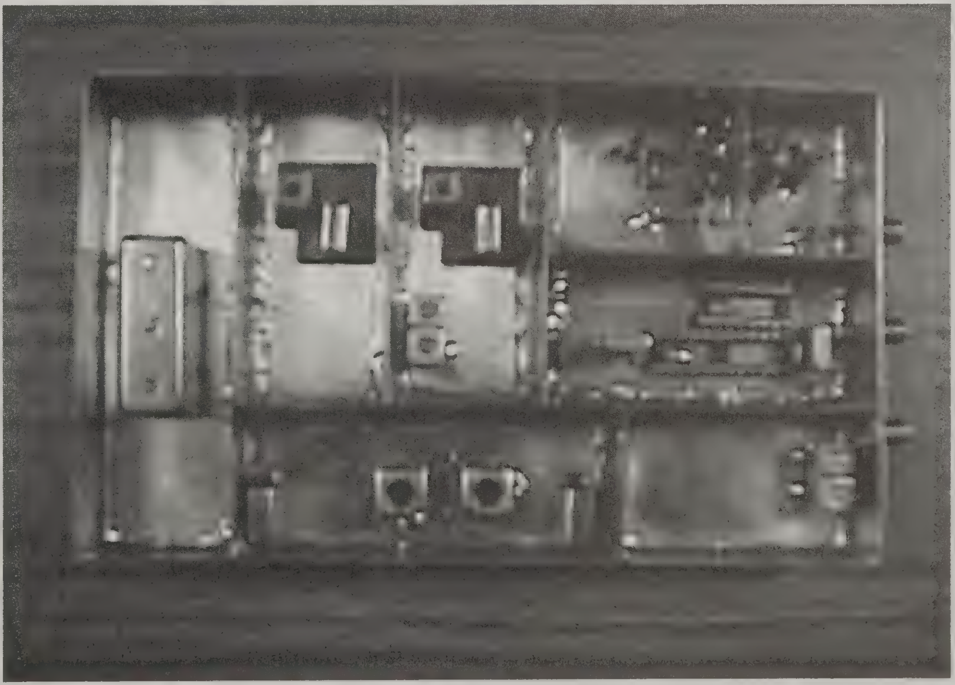


Figure 1. Concpetual Design of the PE1RAH Satellite Transponder. 70cm RX amplifier (right below); CW beacon (right middle); 2m power amplifier (right top); Mixer and IF stage (middle below); two local oscillators (middle top); and, 2m driver (left).

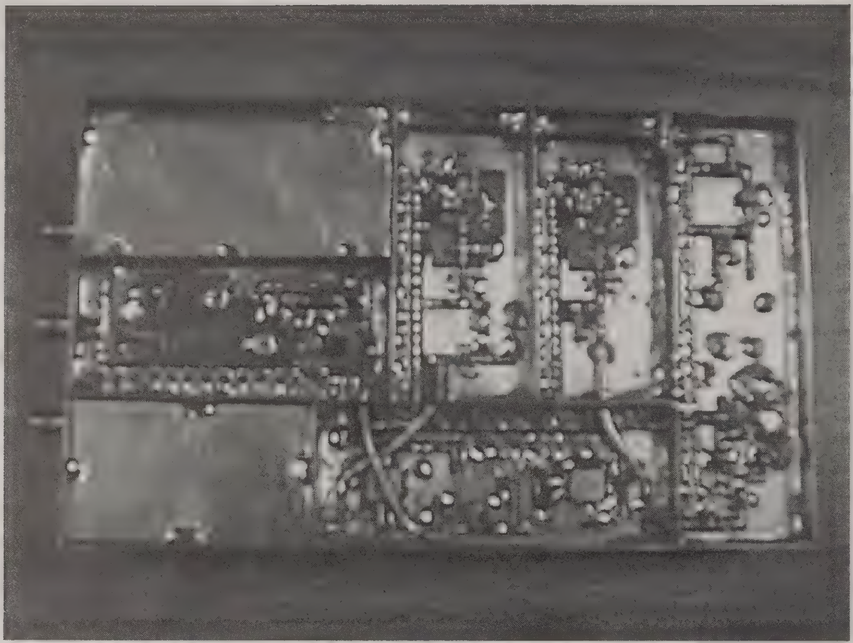


Figure 2. Most of the components in PE1RAH-SAT1 are SMD to make the transponder as small as possible and vibration proof. All units can be 100 percent shielded to avoid oscillations and interference of other units. Only the top left and lower units are shielded. The other units are opened to show the components.

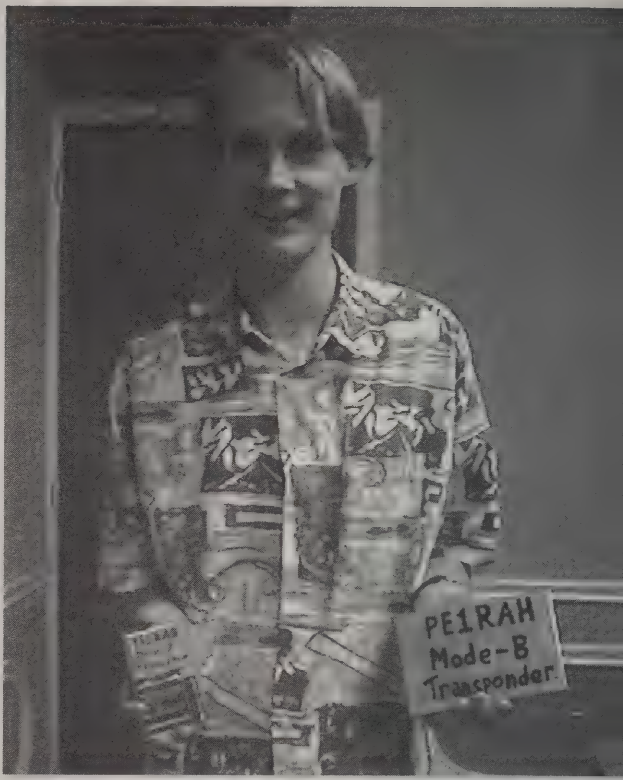


Figure 3. The authors with the Mode-B transponder (left) and a conceptual design of Mode-J transponder (right). I am holding both transponders and I hope to succeed the final stage of this project by successfully orbiting a working Mode-B satellite. In the future I hope to complete design of a Mode-J satellite.

Hard Hat Cam, R/C Vehicle, Rocket, Balloon ATV

App notes available on web page 3

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Field Ops Update: Success Stories

Barry A. Baines, WD4ASW (*wd4asw@amsat.org*)

What a year! More specifically, what a wonderful month! In the preceding 18 days prior to November 16th, when I'm writing this column, we've enjoyed an unprecedented number of milestones within AMSAT:

- **The 18th AMSAT Annual Meeting and Space Symposium in Portland, ME over the weekend of October 28th:** Hosted by George, W1ME, and Carolyn WA1MER Caswell, attendees enjoyed a rich mixture of AMSAT technical discussions and downeast hospitality. AMSAT owes a debt of thanks to them (and their support team) for putting together a very successful weekend. While the weather was not fully cooperative, the activities inside the hotel kept everyone focused not only upon current projects, but creative ideas, new projects currently under development, and building of awareness of what universities and other educational institutions are preparing for launch.
- **Amateur Radio on the International Space Station (ARISS):** With *Station Alpha* manned on November 2nd and Amateur Radio equipment tested over the weekend of November 10th, ARISS establishes a new era for Amateur Radio's participation in manned space flight. ARISS is integral to ISS and is recognized as an essential part of the crew's health and welfare in addition to the educational benefits it provides to students on the ground.
- **Launch of Phase 3-D/Establishment of AO-40:** After nearly 10 years of development, our latest bird was lofted into orbit the evening of November 15th. What a beautiful sight it was as many amateurs viewed the launch of Ariane 507 (V135) via TVRO and the web, and heard the AMSAT Launch Information Net. Now the process has begun of checking systems and slowly positioning it into the intended orbit.

It certainly isn't very often that events of this importance come together at one time. Amidst all of these success stories, this is an appropriate opportunity to highlight additional success stories that are perhaps not quite as well known, but which represent the essence of what makes AMSAT a successful and viable organization. The AMSAT Symposium is our opportunity for the Field Organization to recognize the achievements of those volunteers who have made important contributions to AMSAT's success over the past year. Not everyone is able to attend the Symposium, so let me take this opportunity to share some of the success stories concerning Field Operations that were highlighted during the Symposium banquet. Below are listed the recipients along with wording on their citation:

Steve Thompson, W5PK: For your creation of the AMSAT Patch featured on AMSAT golf shirts as well as offered as a separate item which were first introduced at the 2000 Dayton Hamvention. Your creativity in the graphics arts coupled with your strong interest in making available a unique design for AMSAT is gratefully acknowledged.

Dee Interdonato, NB2F: For your consistent support of AMSAT as exemplified by the high number of hamfests and fleamarkets where you represent AMSAT. In the past 12 months you have handled 6 functions as well as assisted at the Dayton Hamvention. Your willingness to fulfill these functions each year, handle the myriad of questions, and generate interest in the amateur satellite program is certainly appreciated.

Jerry Schmitt, KK5YY: For your very extensive and highly successful efforts to demonstrate the 'Easy Sats' at hamfests, club meetings, and other opportunities as they arise. In the past year you have given numerous demonstrations around the country, including Miami Hamboree, Orlando Hamcation, Dayton Hamvention, and the Arizona State Convention in Flagstaff. Your enthusiasm for giving these demonstrations has resulted in generating genuine interest by 'newcomers' to the hobby as well as enhanced awareness of AMSAT in the amateur community.

Gould Smith, WA4SXM: For your comprehensive updating of the AMSAT-NA Digital Guide, which was made available for the first time at the 2000 Dayton Hamvention. Once again, you have provided AMSAT with a valuable publication that fulfills a significant need of the membership and others who are interested in 'going digital' on the satellites. Your commitment was exemplified not only by the quality of your writing, but arranging for printing and personally delivering the first copies to AMSAT at Hara Arena. Along with the "The Analog Satellites Operating Guide", you have covered the variety of satellites currently available and have provided AMSAT with publications that are of significant benefit.

Mike Seguin, N1JEZ: For your continued support of AMSAT by providing updated materials that were made available at the 2000 Dayton Hamvention. The *Amateur Satellite Resource Guide* is an invaluable document that was used as a handout to over 200 AMSAT Forum attendees and continues to be given out to new AMSAT members. You also updated *Working the Easy Sats* which has been a very popular AMSAT publication and has served as an excellent introduction to amateur satellite communications for newcomers. Your attention to detail and willingness to share tips and experiences with others interested in getting started in amateur satellite communications is deeply appreciated.

Ed Collins, N8NUY: For your continuing support of AMSAT at the Dayton Hamvention by coordinating the Friday Night AMSAT dinner. For the past several years you have served as liaison with the Amber Rose Restaurant, taken reservations from AMSAT members who attended the dinner, and served as 'cashier' for the dinner itself. Your willingness to devote the time and effort needed to handle these details resulted in highly successful AMSAT dinners that are one of highlights of the Hamvention Weekend for AMSAT members.

Mal Preston, NP2L: For your efforts to make the 2000 Dayton Hamvention one of the most successful Hamventions for AMSAT ever. Your personal efforts to generate new memberships and create increased interest in AMSAT by providing a 'membership incentive' were very successful and resulted in record membership activity at a Hamvention.

Ken Chaffee, WA1QXR: For your continuing support of AMSAT at the Dayton Hamvention and other public forums. As in past years, you assisted with setup and takedown at Hamvention as well as served several 'tours of duty' during the Hamvention. Your willingness to represent Amateur Radio at the annual National Science Teacher Conventions and discuss SAREX and other related items are also acknowledged. Your consistent support over the past several years has enhanced the overall success of AMSAT at these events.

Gerd Schrick, WB8IFM: For your strong support of AMSAT by representing the organization at a number of hamfests each year. Your willingness to handle five hamfests over the past year, for example, helped to publicize AMSAT and encourage newcomers to utilize the amateur satellites.

Jim Huhta, AA4MD: For your enthusiastic support of AMSAT and creating new ways to use amateur satellite communications as a means to help others. As an Area Coordinator you assisted with representing AMSAT at the Miami Hamboree, Orlando Hamcation, Dayton Hamvention, and other hamfests. You received permission from the appropriate authorities to install an Amateur Satellite Communications station at Tampa Childrens's Hospital and have used it as a means to encourage young patients to become interested in science as well as help them with the healing process. Your compassion for your patients coupled with your enthusiasm for our hobby has touched a large number of people in many different ways.

Keith Pugh, W5IU: For your continued strong support of Field Operations. You have represented AMSAT at a number of hamfests, including Dayton Hamvention, Hamcom 2000 in Arlington, TX and the South Texas Section Convention in Austin. Your efforts have included responsibility for coordinating booth activities, demonstrating AMSAT software, and providing demonstrations of working the FM satellites. This year you took the steps necessary to make available the latest version of QuikTrak by serving as a beta tester, creating documentation for the program, and making the first copies available at the 2000 Dayton Hamvention. Your personal interest and taking the time necessary to complete these tasks are above and beyond the other 'normal' tasks that you do for AMSAT, such as serve as Net Control Station for the 20 meter International AMSAT Net held on Sunday. Many thanks for your strong involvement which has made a real difference in AMSAT's success over the past year.

Bob McGwier, N4HY: For providing the latest version of QuikTrak to AMSAT-NA. Version 5 is fully 'Y2K Compliant' and includes additional functionality such as enhanced Keplerian Data Editor and menu system in a software package that is compatible with older machines running DOS as well as the latest equipment. First offered to the public at the 2000 Dayton Hamvention, your willingness to license QuikTrak V to AMSAT-NA for distrbution is gratefully acknowledged.

Each one of these individuals has utilized their skills and their enthusiasm to create a meaningful contribution to our hobby. Each found a way to contribute their talent and time to fulfill a need and make a difference to AMSAT and their communities. From the above listing, we had volunteers who:

- Wrote a publication to help educate others and enhanced AMSAT's publication offerings;
- Wrote software and beta tested the product which fulfilled a need (and provided a means to generate donations to AMSAT);
- Donated time and effort to help with Dayton Hamvention;
- Served as net control of an AMSAT net which helps to 'spread the word';
- Served as an Elmer to newcomers to satellites by demonstrating the fun and excitement of satellite communications;
- Assisted with the education process as well as found new ways to help others recover from illness;
- Created new graphic designs for the benefit and enjoyment of our membership; and
- Took the initiative to help generate enthusiasm for membership renewals during Hamvention.

AMSAT is blessed with enthusiastic members who find ways to utilize their interests and talents to help AMSAT and others. My hope is that these examples of the various ways that people can make a difference will help to motivate you to consider how you might consider using your talents and time to make a similar impact on our organization and hobby. Our 'success stories' are not limited to a single area of expertise. Rather, we celebrate the wide variety of ways that these individuals sought to make a difference. Keep in mind that many other individuals who were not recognized at the Symposium continue to make meaningful contributions as well. By recognizing a few individuals each year, however, we all have the opportunity to celebrate the success of the overall organization. Many thanks to all of our volunteers for helping to make AMSAT successful.

As we continue to enjoy the fruits of our success of the Symposium, initiation of ARISS, and the launch of AO-40, let's also recognize that the future viability of AMSAT is also based upon how our members make a difference in their local communities and their interaction within our organization. With the initiation of AO-40, we can expect a significant increase in general interest in the amateur satellite service. Please consider how you can help us to nurture this enthusiasm and translate it into expanding AMSAT's resource base.

Congratulations to our award recipients for their accomplishments during this past year.■

R. Cargill Hall (l) accepts a photograph of a Maine lighthouse scene from Peter Hurd, N1SS (r) as a token of appreciation for his excellant talk on reconnaisance satellites at the AMSAT annual banquet. (Photo by Art Feller, W4ART)

From The Dungeon: Inexpensive Test Equipment

Allan Copland GM1SXX (*gm1sx@amsat.org*)

I'd like to devote this article to the subject of inexpensive and cheerful test equipment for the constructor of equipment for the VHF/UHF and lower microwave bands. We all have to start somewhere but you **don't** need a vast array of test gear. Some carefully chosen items - and some homebrewed kits are all you need. Remember too, that you probably have receivers in the shack that can be pressed into service as test equipment. If you own a wide-band scanner, remember that this can double as a frequency meter by simply coupling a fraction of the signal to be measured into the scanner antenna by means of a wire loop. A 1m length of good quality coax with insulated wire loops at each end can be used for this. No physical contact with the circuit being 'measured' is required … just place one pickup loop in the vicinity of the signal to be sampled and hang the other one over the scanner antenna. A scanner with CW/SSB is the most useful here. Inexpensive and effective – if you already own one. Just don't place *too* much faith in the frequency display .. all those digits don't mean much without accurate calibration of the reference oscillator!

Most of us however, do end up buying some test equipment.

My most heavily used test gear is –

- Ancient analogue multimeter/RF power meter (type CT471C).
- Digital Frequency Meter (two of)
- Diode Probes (various sorts) … mostly home made.
- Prescaler (for use with my RACAL-DANA DFM) … home made.
- Various attenuators - mostly commercial types.

Figure 1. Watson FC-130

A quick look through various surplus equipment lists in magazines and on the Internet will unearth many items of use to the radio amateur. One such item is a digital frequency meter. Sure, you can go out and buy a inexpensive pocket DFM for around $150 that will suffice for many purposes … I have one. They are great for quickly tuning up multiplier strips and the like and even have a crude but effective *relative power* meter included. They are fine for general use but one of their problems is the lack of a precision frequency reference … they use a standard crystal oscillator as a reference. Mine is a Watson FC-130 (see Figure 1). This works well to at least 1.3GHz.

For more demanding work you might want to consider a good second-hand DFM and a pre-scaler unit to cover your frequency of choice. You may remember from my last article that I recently bought a **Racal-Dana 9916** DFM at a rally (Figure 2). It cost about $125. Measuring ranges are 10 Hz-60 MHz and 40-520 MHz. This covers a few of the lower frequency Amateur Radio allocations and is therefore a very useful tool for the constructor. These DFM's are readily available from a number of UK surplus dealers. The 9916 DFM is a professional grade unit with a built-in mains (110/230V switchable) power supply. They were also made in the USA -and are probably available there on the surplus market. Although moderately old and of limited frequency range, this meter has a lot of good points not seen in today's bargain-basement offerings. The most important is the use of a *canned* crystal oven based frequency reference. This ensures that after a short warm-up period, the calibration can be relied upon to be stable and drift-free. In contrast, the pocket DFM has no such stabilisation and cannot be relied upon to the same degree. The Racal-Dana DFM also has a reference 1 MHz output on the rear panel … very useful as a frequency 'standard'.

Watch Those Milliwatts!

FM's and other RF monitoring equipment are generally designed to accept only low levels of RF energy. This means that you should use suitable attenuators when measuring the output frequency of power amplifiers etc. If in doubt, check the manufacturer's data. Maximum levels in the ***tens of milliwatts*** range are common. Destruction of the DFM front end by overload is not covered by your warranty! Alaways read the instructions.

Racal-Dana DFM – Extending the Coverage

The next problem, that of inadequate frequency coverage (for the 1.3 and 2.4 GHz bands), is easily handled by a simple prescaler circuit. A pre-scaler takes an incoming signal and feeds it to a binary divider chain thereby producing output in a frequency range your DFM hopefully can cope with. Pre-scalers are basically a cascade of D type 'flip-flops' … for every two cycles of AC fed in .. only one cycle appears at the output. These flip-flops may be cascaded to give /4, /8 etc. Since they are simple binary devices, the output is a square wave. This is not a problem for the DFM. Some pre-scalers can be 'programmed' to suit the users needs -the frequency division can be 'programmed' by setting links -but I chose to use a simple and cheap 'divide by 4' pre-scaler designed for use up to 3 GHz. Pre-scalers generally use 'emitter coupled logic' a forerunner of the common TTL (Transistor-Transistor-Logic) seen in some common logic chips. ECL while greedy in terms of power requirements can switch at

Figure 2. Racal Dana 9916.

very high speeds, hence its popularity in pre-scalers.

Shown below is a simple divide by 4 pre-scaler circuit for the Racal-Dana frequency meter that takes its coverage to around 2.4 GHz. The unit should be built *dead bug* style with the shortest possible lead lengths - especially around the input stage. I recommend using a small diecast box with the circuit built inside the lid on a sheet of copper, or a piece of PCB material. A pair of BNC connectors can be used to take the signals in and out of the unit while securely clamping the copper groundplane in place. *Dead bug* construction is preferable to the use of a PCB because the lead lengths can be held to an absolute minimum, which helps the frequency response. Pin 3 is not used and should be left unconnected. If you have access to SMD resistors, a 51 ohm resistor (or two 100R in parallel) can be used as the input load. Alternatively, a standard low wattage wire-ended resistor can be used, but crop the leads as short as possible.

The MB506 divide by 4 prescaler chip used is available from a number of sources (Figure 3). I bought mine from LMW Electronics. **NOTE ... the MB506 uses a +5V supply**!

Attenuators

Attenuators are deadly boring, but essential items for the testing of receivers and other equipment. One of the problems is that I've found that do it yourself ones are difficult to make in large values of attenuation. This is in part because of RF leakage. It ***is*** possible for the radio amateur to manufacture useful attenuators using 50R printed microstrip. At frequencies under about 500 MHz, carefully laid-out attenuators (short leads!) using BNC or N type connectors and double sided PCB may be built using carbon type resistors. These should be fitted in screened enclosures. Above 500 MHz, attenuators built on double sided PCB using 50R printed microstrip are to be preferred. SMD resistors are recommended, although their power handling is fairly limited. The Microwave Handbook Vol 2, pages 10:5 to 10:12 contains some useful suggestions for attenuators.

I've played with DIY attenuators but the *big boys* such as Marconi-Sanders and Mini-Circuits produce a range of very useful *potted* attenuators. In general, they consist of a tubular body with N type or SMA connectors fitted at each end. You may argue that attenuators are **only** resistors, but this is one area where commercial products are to be preferred. The better quality attenuators come with a calibration chart of *Attenuation vs Frequency* - often stamped on a metal label attached to the unit. This makes clear the **actual** attenuation over a range of frequencies. The actual variation of attenuation does not vary hugely (at least in my experience) - but it is useful to know.

My Marconi-Sanders 20dB attenuator varies from 19.1 to 20.0dB over a DC-12 GHz frequency range… around a 5 percent variation. Not a great change, and unlikely to be a problem for amateur use. Mini-Circuits produces a number of attenuator kits … a selection of useful values for the experimenter. They are not cheap, but if you are a serious experimenter, they could be of great value to you. The Mini-Circuits ones are specified at 1GHz although they will work well at other frequencies. If you have a choice in the type that you buy, the 'N' type attenuators are chunkier and tougher than SMA types and therefore to be preferred for amateur use. One other thing to be aware of is power handling. Many attenuators are rated at 1W max continuous power. Overload them at your peril!

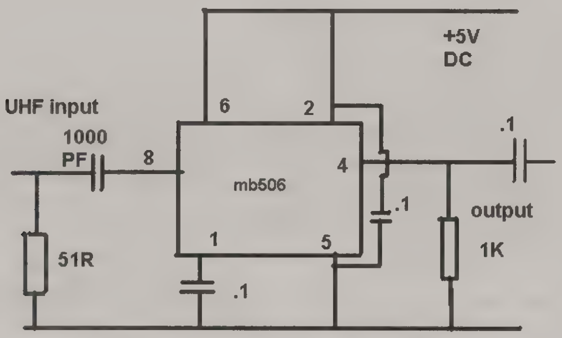


Figure 3. MB506 Pre-scaler.

Sometimes, **step attenuators** turn up on rally stands and in surplus shops. These allow a range of attenuation values to be selected via a rotary switch. If you are offered step attenuators manufactured by reputable manufacturers such as Hewlett-Packard or Marconi, you should consider purchasing one. They are *very* useful items.

Power Measurement on the Lower Microwave Bands

My most heavily used item of test equipment in the shack is another piece of ex-military scrap. This is the **G&E Bradley CT471C electronic multimeter**. This interesting tool looks not unlike an AVO 8 but is more sophisticated although it looks like it belongs in a museum. It is basically an electronic voltmeter serving the usual sort of meter functions - AC and DC voltage and current from 12millivolts FSD to 1200V FSD and current from 0.012mA-1.2A. It does however have another trick up its sleeve. This meter can measure RF power - from LF to 1.5 GHz. It does this by means of a few special meter ranges and some external measuring heads - diode probe units. The measuring ranges are 0.012V, 0.04V, 0.12V, 0.4V and 1.2V and 4V. This covers around **–26dBw to +25dBw** … a **very** useful power range. I use a simple table (dBm-Volts-Watts Conversion) ripped out of the Mini-Circuits catalogue to translate the displayed voltages into watts, milliwatts and dBm. Although ancient - (this meter is so that it uses old germanium transistors), I find this to be one of the most useful items of test gear I've ever bought. It was supplied with four diode test heads, a coaxial lead set and a set of moulded rubber test leads similar to those supplied with the AVO 8. The test heads supplied are:

- 50R terminated (good for up to 320milli-watts)
- 75R terminated (as above)
- unterminated 4V
- unterminated 400V

The big surprise was the cost $35 (plus $15 postage!).

They are probably available from a number of sources of ex-military surplus gear. I bought mine from John Birkett who advertises in some of the electronics magazines (Figure 4). This is a very sensitive RF meter and perfect for tuning up multiplier strips (in conjunction with a DFM). I like it a lot. If you are offered a **CT471C** at a sensible price, buy it! The RF probes work to at least 1.5 GHz.

If like LA2QAA, you live on a remote island in the middle of nowhere and can't get hold of a CT471C meter, there is an alternative to the power meter mentioned above. This is the humble diode probe. Diode probes can be of the terminated or unterminated sort and can be bought commercially or easily made at home.

A good quality **terminated** diode probe can be built that will work to at least 1.5GHz by making use of readily available parts. All that needed is a good quality 50R BNC 'T' piece, a BNC terminator (50R) - (available from most computer stores), an 1N914 diode and a 1000 pF capacitor. Terminated probes allow relative power into a 'known' load to be measured.

Terminated Diode Probe

This type consists of nothing more than a 50R resistive load (computer network terminator), a diode rectifier (1N914 or similar) and a 100pF miniature ceramic decoupling capacitor.

When building terminated probes, choose a silver plated BNC 'T' rather than the cheap plated ones used for computer networks. You can usually find these at rallies - the silver plated ones generally have a dull and tarnished look, however, they are much easier to solder to! The 'computer types' could be used as a last resort.

Before starting work, I normally break off the top half of the locking ring by snipping the locating slots on the ring open with a pair of side cutters and using a pair of long nosed pliers to break off most of the outer metal shell. You should be left with a ring of material, some rough edges and the exposed outer fingering of the body shell. This fingering forms the ground connection and is easy to solder to. The center pin forms the RF connection point.

Construction is simple - crop the diode leads very short 2mm or so, and quickly solder the cathode connection of the diode (the banded end) to the center pin of the connector quickly (but properly) so as not to melt the dielectric.

Tin part of the grounded fingering - a spot of flux sometimes helps here. Take a 1000pF ceramic capacitor and crop the leads back to 2mm and tin them. Solder the capacitor between the fingering and the free end of the diode, taking care to keep the leads as short as possible. Bear in mind that the RF performance is heavily dependent on the lengths of the connecting wires. ***Short is good.***

The (capacitor and diode) lead lengths are exaggerated for clarity in the drawing - in reality they should be cropped as short as is feasible. I normally use RG58 to take the DC output to my multimeter - solder the ground to the locking collar and the inner to the junction of the capacitor and diode. Alternatively you can use twisted pair cable. Attach the 50R terminator to the free port on the BNC. You now have a good quality coaxial terminated probe capable of measuring power (to around 500mW max) to at least 2 GHz., when connected to a standard moving coil multimeter on the DC volts ranges. If you use a 20k/Volt meter or better, this makes a very useful and compact power meter. Fairly low power levels can usually be measured on the low voltage ranges or alternatively the 50uA current range on a 20k/Volt meter.

Generally, you will only need such a probe to tune for maximum output - but if you can get access to some basic test gear (UHF signal generator and power meter) - it is possible to 'calibrate' the probe against a 'real' power meter at a selection of frequencies - by using a switched attenuator.

Even without being calibrated, these probes are very useful to the amateur experimenter.

The 50R 'terminator' provides a load for the circuit under test but RF power levels into the unit should not really exceed 500mW - because heating of the terminator causes its resistance to change (along with your 'calibration').

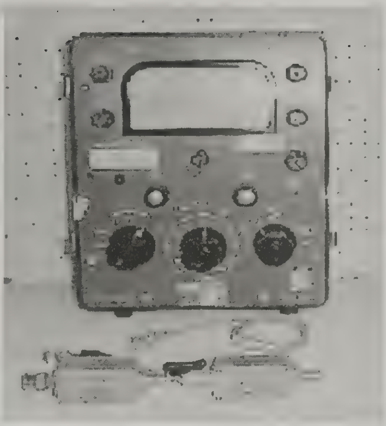


Figure 4. CT471C RF Meter.

I usually encapsulate the exposed components in epoxy putty after construction to protect against damage. You can buy epoxy putty at any good hobby shop. Electrically insulating and sets like stone!

Always remember that the terminated probe offers *a DC path to ground* (via the 50R terminator). This means that you will get incorrect readings from any circuit that has DC present on the point under test (Figure 5)! This is what the completed probe should look like before being encapsulated in epoxy putty. I find these probes very useful when tuning up equipment. They work to at least 1.3 GHz (and probably are good for 2.4).

Unterminated probes are useful when you only need to tune for maximum power ..'max smoke' .. such as when tuning up a multiplier strip. Unterminated loads do not contain a load for the circuit under test and therefore only offer relative power measurements.

Unterminated Diode Probe

This is the simplest type of probe to build (Figure 6). It is a simple rectifier/ capacitor

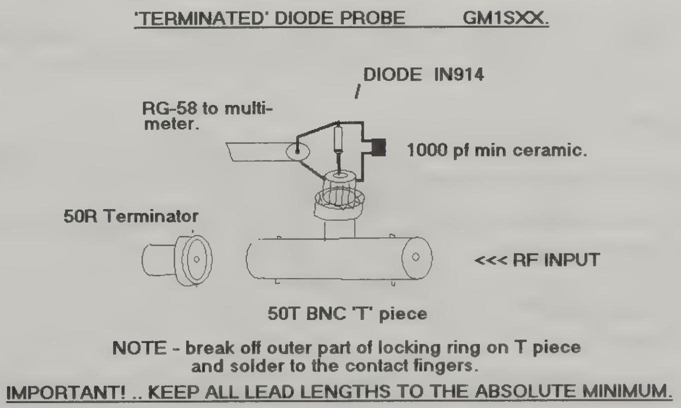

'TERMINATED' DIODE PROBE GM1SXX.
DIODE IN914
RG-58 to multi-meter.
1000 pf min ceramic.
50R Terminator
<<< RF INPUT
50T BNC 'T' piece
NOTE - break off outer part of locking ring on T piece and solder to the contact fingers.
IMPORTANT! .. KEEP ALL LEAD LENGTHS TO THE ABSOLUTE MINIMUM.

Figure 5. Terminated Diode Probe.

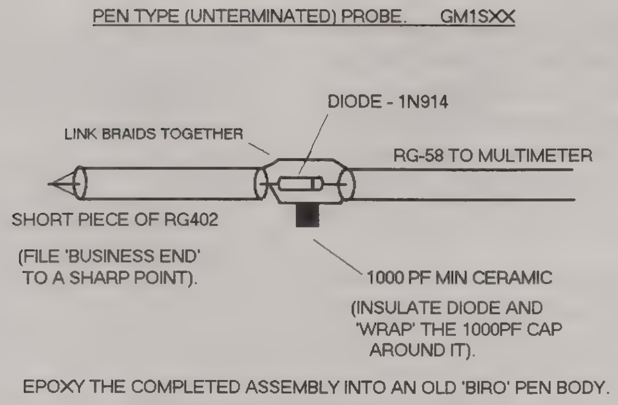

PEN TYPE (UNTERMINATED) PROBE. GM1SXX
DIODE - 1N914
LINK BRAIDS TOGETHER
RG-58 TO MULTIMETER
SHORT PIECE OF RG402
(FILE 'BUSINESS END' TO A SHARP POINT).
1000 PF MIN CERAMIC
(INSULATE DIODE AND 'WRAP' THE 1000PF CAP AROUND IT).
EPOXY THE COMPLETED ASSEMBLY INTO AN OLD 'BIRO' PEN BODY.

Figure 6. Unterminated Diode Probe.

arrangement and is useful for 'sniffing RF' in oscillator / multiplier chains.

At the higher (over 100 MHz) frequencies you are likely to encounter, you don't normally need an ground connection *hand capacity* will usually provide an adequate earth return. Diodes such as the OA90, 1N914 and even the humble 1N4148 will work in this circuit. The capacitor can be a 1000pF ceramic disk type with very short leads or better still, an SMD chip type. Any value in the 470-1000pF range works fine. I find that old 'BIRO' pen bodies make suitable housings for this sort of probe. A small length of RG402 (1-2 inches) of semi-rigid cable with the *business end* filed to a point makes for a very useful contact probe. Epoxy the assembly into the pen body after testing. I usually use a miniature diode (1N914) and a 1000 pF chip capacitor feeding the DC output to a length of RG58 cable. If you use a miniature ceramic type, *wrap* it around the diode so that it will fit inside the pen body. Building time is 5-10 minutes _. Very simple and very useful. The probe then connects to my analogue voltmeter. Digital meters are almost useless for this sort of work ... because of their *settling time*. With an analogue meter, you can see at a glance, whether the power is increasing or decreasing ... it is **much** more useful. A 20K/volt (or greater) type is to be preferred.

Commercial Offerings

It is also possible to buy professional grade *coaxial probes*. These look like an 'N' type to BNC adapter – manufactured in two parts - but contain an 1N23 or similar coaxial microwave diode fitted into a sleeve containing a decoupling capacitor.

These are available sometimes on the surplus market and I have seen them on sale on the Internet (Surplus Sales of Nebraska *http://www.surplussales.com*). These probes can be used to make relative power measurements on the lower frequency microwave bands. I saw some for sale at $60 (USA) recently. Because the professional coaxial probes are *un-terminated* and don't present a known load to the circuit under test, they are only really suitable for relative measurement of RF power. They will however work to some pretty high frequencies.

Their coaxial construction and the use of a *genuine* microwave diode give them some advantages over the simple probes I've been describing - especially with regard to their performance at the higher frequencies. For my part, I think that $60 is a bit expensive for the workmanship and components involved.

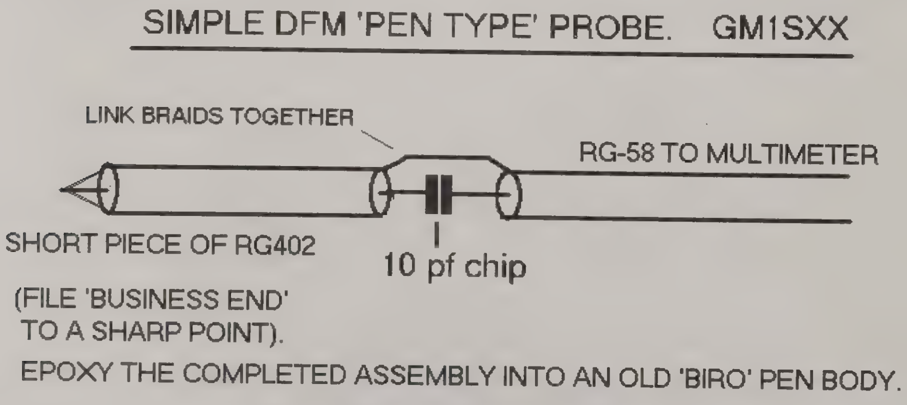

SIMPLE DFM 'PEN TYPE' PROBE. GM1SXX
LINK BRAIDS TOGETHER
RG-58 TO MULTIMETER
SHORT PIECE OF RG402
10 pf chip
(FILE 'BUSINESS END' TO A SHARP POINT).
EPOXY THE COMPLETED ASSEMBLY INTO AN OLD 'BIRO' PEN BODY.

Figure 7. Simple DFM Pen Type Probe.

RF probes for DFM's (DFM PEN PROBE)

After buying my FC-130 DFM, I got fed up trying to *sniff* RF with the supplied telescopic antenna. It was useless! Even with a pick-up loop, it was a hassle. I thought about the problem and came up with a very simple probe that works well (Figure 7). Yet again, this is a variation of the *pen probe* shown above. This time, I used the RG58 and RG402 shown previously, but built a *straight through* type of probe.

The coax outers are connected together and the inner conductors are connected together via a 10pF chip capacitor, (keeping the leads short!) thus placing a blocking capacitor in the signal path. The assembly is then fitted into an old *BIRO* pen body as before and secured with epoxy adhesive. This simple probe works fine to at least 1.5 GHz and provides DC isolation. The capacitor value is not critical - any value in the 10-100pF range will offer a low value of reactance at high frequencies. A 10pF capacitor has a reactance of 12.26R at 23cms wavelength ... this will block any DC but behave like a low resistance path to RF. I've used one of these probes for several years with good success. Although I haven't tried it yet, I'd imagine that a *gimmic capacitor* would probably work well here too - (just a couple of short lengths of insulated wire twisted together to form a low value capacitor).

Grounding

I've tried these probes with and without a grounding wire ... it makes little or no difference whether you ground the probe shield or not. At VHF and above, I've found that the probes work just as well without grounding. I should point out here and now that never having ventured into HF radio, I have absolutely *no* experience of RF circuits operating at less than 96 MHz (honestly!). As one lowers the frequency being measured, the need for grounding would become greater. If you need a probe for frequencies below 100 MHz, a simple clip-on ground might be useful. The value of the coupling capacitor should be increased too, to around 100pF, to provide a low reactance path to the RF signals.

Luxury 3 Range RF Power Meter

This one is simple to build, has three measuring ranges and will detect RF power in the range of microwatts up to around 2 watts, a very useful measuring range (Figure 8). Being terminated, it could be calibrated against a *real* power meter or simply used as a relative power meter. HP2800 Schottky barrier diodes are used to give good performance. Any moving coil meter movement of 50-100uA will suffice in this design. I used a *recycled* one from an old piece of broken kit. With analogue meters, large is good… easier to see small needle movements. The input load resistor should be rated to handle at least 2 watts although 5 watts would be a better rating. This is because resistors alter in value as they warm up, thus upsetting the calibration. DON'T be tempted use a wirewound type. Paralleled carbon film resistors may be used .. spread them around the N type center pin in a neat *star* formation and solder direct to the groundplane using the shortest possible leads. Just make sure they have a combined value near 50R. The 1n capacitors and diode pairs may be fitted between adjacent resistors (on opposite sides of the coax centre pin.) and the output leads twisted together and taken to the meter circuit. 'PLOP' or'COFFIN' capacitors are good for this circuit and should be used if you have access to them. If you don't have any of these capacitors in your junkbox, miniature ceramic (short) leaded ones will also work. The upper frequency limit of this meter depends very much on keeping the lead lengths short. My preferred construction method is to use a sealed two part plastic case ('FIBOX' range from Farnell Electronics or similar) and to place a sheet copper screen .. or PCB backplate .. inside the transparent lid.

A printed paper faceplate is *sandwiched* between the copper plate and the clear plastic lid to give a professional and durable appearance. I printed my faceplate lettering on my PC using the Paintshop Pro graphics software. The rotary *range* selector switch, meter fixings and N type input connector hold the *sandwich* together. The *RF front end* components are all mounted *dead bug* style over the copper groundplane with the shortest possible lead length. This construction method is ideal to give extended RF performance. The end product is a very useful test instrument for the amateur constructor.

If you want a more accurate meter than this, I'd suggest building the one described in *The Microwave Handbook Vol 2,* 10.2.2 (RSGB).

Tuning/Trimming Tools

Beginners are often tempted to use *jewellers* screwdrivers to adjust tuning slugs and capacitors. I must confess to having done the same myself at times in the past. (Shame on you! .... LA2QAA) DON'T do it. You will run into problems with 'hand capacity' and detuning effects and worse still will probably fracture the fragile ferrite or powdered iron cores. I can vouch for the difficulty in extracting the broken fragments … yes the core broke! Either use nylon trimming tools, or better still, a phosphor-bronze trimming tool. For hexagonal cores, nylon tools are ideal. They are cheap and effective. The phosphor bronze tools use a plastic sleeve into which is glued a double-ended metal adjuster. This type of tool only handles slotted cores and trimmer capacitors. The metal material used is soft and will not damage the cores. Furthermore, it doesn't de-tune the circuit being adjusted - unlike a jeweller's screwdriver. I paid $3 for mine and I've owned it for about ten years. Thirty cents a year is a small price to pay to avoid cracked cores! Do yourself a favour and buy one of these tools. The best way to use this tool is to hold it by the plastic body, avoiding the metal part. This minimises any minor de-tuning due to *hand capacity* effects. Tuning is an acquired skill. The more experience you get, the better you will become at it. *Idle twiddling*, though is to be discouraged at all costs and if you must practice, do it on something like an old PMR radio … don't practice on your ICOM 821. If you are just plain mean, a filed down match (preferably used!) makes a far better trimming tool than a jeweller's screwdriver. I kid you not.

In the Pipeline

I'm hoping to devote the next article to a new piece of software for the DIY satellite enthusiast. For anyone attending the University of Surrey bash … you might get a sneak preview.. I hope to bring along a working version and example code for a DCOM based satellite-tracking program. **DCOM** (**D**istributed **COM**ponent object model) is a means of providing modular software that can be accessed from an external *front-end* program. This allows the user to write their own personalised version of the code … to add the *bells & whistles* that they want, while not affecting the functioning of the core program.

Using a simple **Visual Basic™**, **C** or even **PERL** interface, the user can personalise the look and function of the finished article. The software can even export data directly into many Microsoft™ applications. If there is a reasonable level of interest in this software, it could be made available via a WWW site. Astronomers have had a similar system for some time, for telescope pointing. Why should they have all the fun?

Feedback

I've had some feedback from a couple of readers re my previous article on PIC microcontrollers. At least this shows that at least some of our members are interested in these useful devices. The system I described in the article is really simple to use and requires very little financial outlay. The programming software (PICBASDE) and manuals are *free* via the Internet. I've been having fun with these little computers for about three years and I keep finding new uses for them. They are incredibly versatile. At the moment, I'm working on PIC software to diagnose problems in carpet weaving looms … now that really **is** off-subject - but it serves to demonstrate the versatility of the PIC microcontroller.

Thanks for the feedback guys. 73, Al. ■

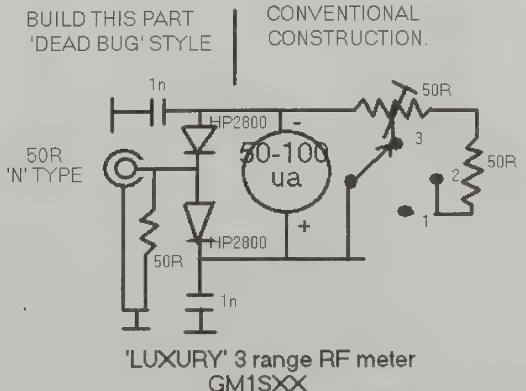


Figure 8. Luxury 3-Range Power Meter.

AMSAT Journal Telemetry

You're Invited to OSCAR SKN 2001

All radio amateurs worldwide are cordially invited to participate in AMSAT-NA's 29th annual Straight Key Night on OSCAR, to be held from 0000 to 2400 UTC on 1 January 2001.

It's totally informal: no rules, no scoring and no need to submit a log. Just have fun operating Morse with a straight hand key via any Amateur Radio satellite (including the moon). Call CQ SKN or answer such calls from other stations.

In keeping with the friendly tradition of this event, each participant is encouraged to nominate someone he or she worked for *Best Fist*. Those nominated will be listed in an AMSAT News Service bulletin and in *The AMSAT Journal*. Please send all Best Fist nominations to W2RS via e-mail (*w2rs@amsat.org*), packet radio (W2RS @ WA2SNA.NJ.USA.NA) or *snail-mail* to W2RS' callbook address.

AO-40 Status Report from DJ4ZC

The following AO-40 status as of 20 November 2000 was reported via telemetry:

- AMSAT OSCAR 40 had a perfect launch on Nov. 16 and was injected into a nominal orbit.
- Transmission of telemetry from OSCAR 40 on 70cm was expected 3h after launch. But we ran into a problem with the 70cm TX. Consequently the spacecraft was switched to use the 2m middle beacon as downlink for telemetry. This required a "repeater program" in IHU-2 which was uploaded.
- After communication was established, the health of OSCAR 40 was analyzed and everything testable at this stage except for the 70cm TX was found to be nominal and fine.
- The attitude control system then was calibrated and torque operations were started to take the attitude to 270/0. This reorientation should be finished in a few days. Then we are ready for the first planned orbit change (400N-mtr) resulting in 50000 km apogee altitude. The attitude will also allow a. thorough study of the 70cm TX problem with the hi-gain antenna.
- The two 2400 MHz transmitters were operated and are o.k.
- Pictures from the separation sequence are being downloaded and will shortly be available on our website. (*Editor's Note: See page 1 of this issue.*) On the WWW pages, we will also show the test-schedule for some first amateur operations.
- Steps after 1st orbit change: test the electric propulsion system and then use it to further increase appogee altitude using the arcjet before the big i-change.

Discussion on Proposed AO-40 Burns, by Richard Limebear, G3RWL

I am sure I wasn't the only person surprised when Karl Meinzer, DJ4ZC announced that the first burn of AO-40 would be done with the 400N motor. (Previous announcements had said that there would first be several months of burns using the arcjet propulsion.)

So, I asked Viktor Kudielka, OE1VKW, about this burn as he was a prime consultant on the propulsion planning. After the 70cm problem arose, DJ4ZC consulted him by phone for different options. Viktor's (three) replies to me appear below and he has kindly allowed me to share these with other members. Thanks Viktor.

With two very different motors on board the satellite in a GTO, the goal to achieve a highly elliptic, highly inclined orbit of 16 hours period with the apogee somewhere above the northern hemisphere for at least 10 years (and maybe a total lifetime of more than twenty years). And if possible, after the operating lifetime, we would like to guarantee a proper decay in order to leave no rubbish in space. Therefore, the number of alternatives to be considered is pretty high. In addition, there are other constraints, like sun angle for the s/c attitude required for the burns, power budget, link budget for the intermediate orbits, propellant consumption, etc.

A major inclination change can only be done with the 400N motor. The plan is, to do this inclination change at apogee and with an argument of perigee of around 270 degrees. This seems to be the most economic alternative to achieve a new argument of perigee of around 355 degrees and an inclination, such that the argument of perigee will very slowly decrease, reaching 180 degrees not before 10 years have passed.

There is a trade-off between the height of apogee of the intermediate orbit and the delta-V required for the inclination change. If one chooses a higher orbit, some MMH/N2O4 propellant can be used for achieving this higher orbit. Whether one does this before using the arcjet motor, in between the burns of the arcjet or afterwards, causes just very subtle differences.

The advantages of a first burn of the 400N motor are:

- *We get a precise calibration of the performance of this motor and can plan the inclination change more accurately.*
- *With a higher orbit, the changes in argument of perigee and RAAN (primarily due to the oblateness of the Earth but also the influences of the Moon and the Sun), are decreasing.*
- *This eases the management of the arcjet burns, since attitude changes are required for compensating the changes of argument of perigee and RAAN.*

I had delivered a set of alternatives, depending on the height of apogee for the inclination burn (58000 km to 100000 km).

The higher the apogee, the less propellant for the 400N motor is needed. Therefore, we can use some of it already for increasing apogee height. Whether we start with the biprop or the arcjet motors is in principle irrelevant - except for the sun angle. The advantage of getting a first boost of about 120 m/s is, we have then already slower changes of argument of perigee and RAAN. This facilitates the management of the arcjet burns. We have left about 1000 m/s for the inclination change and therefore we have to go for an apogee between 70000 and 80000 km, where DJ4ZC sees no problems with communications or accuracy of attitude.

For a higher and longer orbit, the power budget is better, since more time is available for loading the batteries for the (maximum) one-hour burn of the arcjet. And with a constant attitude, the losses due to the geometry of the orbit around perigee are reduced.

Sorry for such a long description, but it is a very complex problem. Vy 73 de Viktor OE1VKW

Presently, Ronald Ross, KE6JAB is a member of Alain Hubert's *The Wall* expedition to Dronning Maud Land, Antarctica. He will be assisting with the communications for the expedition as well as operating a satellite ground station and conducting research for NASA. The focal point of the expedition is the ascent of Holtanna, a 2600m granite wall, by a group of international climbers. A film crew is along to document the climb and Antarctica. Ronald will be deploying a weather station, WX2, built by Stanford University students he has been mentoring engineer students for the past three years. Last year, he deployed WX1 at the basecamp Blue One. WX2 is a new design with more features and it will be left over the winter in Antarctica. Data will be sent back by APRS over the Internet to Stanford University. The above photograph shows an Arrow and turnstile antenna after a four-day storm. We hope to publish the results of KE6JAB's trip in a future issue of *The AMSAT Journal*.

AO-40 Telemetry Decoder Available

Nino Porcino, IZ8BLY has developed software program that displays *raw-data* telemetry transmitted by the AO-40 satellite via a PC sound card. The program is available via http://iz8bly.sysonline.it/. The term *raw data* means that the program does not interpret the telemetry information, rather it only prints ASCII bytes See Figure 1). The modulation format used by AO-40 is quite simple as it's a 400 BPSK Manchester-encoded transmission, frame oriented, no FEC, CRC certified, containing 512 bytes of ASCII and binary data. Total throughput is 200 bits/s.

Porcino wrote this decoder program in less than a week re-using many parts from another program called *Stream* (the user interface is similar). Decoding is done by sampling audio at 8000 Hz (8-bit resolution) then down samples to 2000 Hz and to 400 Hz where phase detection is done. The clock synchronization is done by a Costa's loop-like algorithm working on 5 steps at 2000 Hz.

Porcino reports that the first version of this program is very *basic* and totally un-optimized for use. For this reason a quite powerful PC is needed. The program is free, however monetary contributions are welcomed. You may contact IZ8BLY at: Via dei Tulipani 21, 89133 Reggio Calabria, Italy of via e-mail: *nino.porcino@tin.it*.

InstantTrack 1.50 Now Available

Paul Williamson, KB5MU reports that InstantTrack version 1.50 is now available. This verison is more than just a Y2K fix, but not a major rewrite. Everything you love about the original InstantTrack is still there. It's still a DOS program, and now runs on even more machines than before.

A complete description of all the improvements runs to 17 pages is is available via the InstantTrack web pages: *http://www.amsat.org/amsat/instanttrack/*. You can also obtain a copy of this version via this WWW site.

Information on AO-27's Recent Software Reset by Michael Wyrick, N4USI, AO-27 Ground Controller

AO-27 suffered a software reset on 31 July 2000 while in the southern hemisphere and several minutes before entering the eclipse. This reset put the onboard CPU back to the Bootloader software that places the satellite in *safe mode*. While in safe mode, the transmitters are turned off and all high level functions are suspended.

This places the satellite in a condition that ground controllers need to react to which normally means uploading the high level software and executing it. It was decided that since the last reset was 6 1/2 years ago, this reboot might be a single event upset or some other *random* reboot. With that in mind, ground controllers downloaded only a small section of memory and started to upload the high level code.

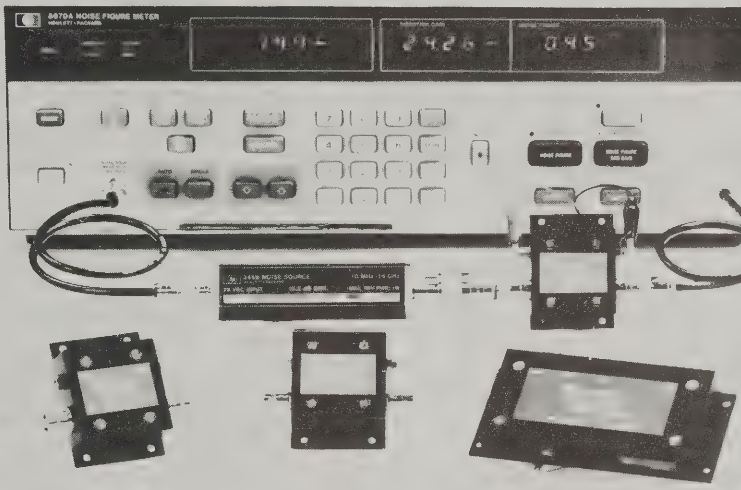
This was not an easy task, the primary control station used for uploading code was not used for over five years and required days of work to get back online. Once the station was setup for uploading, the code was placed onboard AO-27. When the execute command was given, the satellite ran the high level code for a few seconds, then rebooted. This may show that the reboot was not caused by a random act, but it is not conclusive.

Several sections of memory were downloaded from AO-27 and no conclusive data was found to explain the second reboot. Ground controllers are looking into several leads. Jumping to conclusions as to cause of this situation are not productive during this process. It will take controllers time to analyze and determine the cause for the reboots. It is unfortunate that during this process the analog repeater cannot be used, but the work done now may lead to a longer lifetime of AO-27. There is no direct evidence at this time as to cause. During the checkout that has been performed so far, controllers have not found anything onboard to be defective. This is good news and gives us hope that a recovery is possible.

Facts known about A0-27 as of 23 August 2000:

- CPU rebooted on July 31, while in TEPR 6, southern hemisphere, in sunlight. This means the batteries did not run down to cause the reboot.
- TEPR times that were commanded on July 26 were intact and did not cause the reboot, i.e. the batteries were charged.
- The last CPU telemetry frame was recovered and shows battery charge state as OK.
- The code was sampling telemetry at the time of the reboot.
- Software Uptime was over 6 1/2 years, (February 1994)
- The amateur transmitter works at exciter, low, and high power settings
- The amateur receiver works

High Performance **vhf/uhf preamps**



Receive Only	Freq. Range (MHz)	N.F. (dB)	Gain (dB)	1 dB Comp. (dBm)	Device Type	Price
P28VD	28-30	<1.1	15	0	DGFET	$29.95
P50VD	50-54	<1.3	15	0	DGFET	$29.95
P50VDG	50-54	<0.5	24	+12	GaAsFET	$79.95
P144VD	144-148	<1.5	15	0	DGFET	$29.95
P144VDA	144-148	<1.0	15	0	DGFET	$37.95
P144VDG	144-148	<0.5	24	+12	GaAsFET	$79.95
P220VD	220-225	<1.8	15	0	DGFET	$29.95
P220VDA	220-225	<1.2	15	0	DGFET	$37.95
P220VDG	220-225	<0.5	20	+12	GaAsFET	$79.95
P432VD	420-450	<1.8	15	−20	Bipolar	$32.95
P432VDA	420-450	<1.1	17	−20	Bipolar	$49.95
P432VDG	420-450	<0.5	16	+12	GaAsFET	$79.95
Inline (rf switched)						
SP28VD	28-30	<1.2	15	0	DGFET	$59.95
SP50VD	50-54	<1.4	15	0	DGFET	$59.95
SP50VDG	50-54	<0.55	24	+12	GaAsFET	$109.95
SP144VD	144-148	<1.6	15	0	DGFET	$59.95
SP144VDA	144-148	<1.1	15	0	DGFET	$67.95
SP144VDG	144-148	<0.55	24	+12	GaAsFET	$109.95
SP220VD	220-225	<1.9	15	0	DGFET	$59.95
SP220VDA	220-225	<1.3	15	0	DGFET	$67.95
SP220VDG	220-225	<0.55	20	+12	GaAsFET	$109.95
SP432VD	420-450	<1.9	15	−20	Bipolar	$62.95
SP432VDA	420-450	<1.2	17	−20	Bipolar	$79.95
SP432VDG	420-450	<0.55	16	+12	GaAsFET	$109.95

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If you would like to follow AO-27, the exciter on 435.797 MHz is switched on full time and turned on to low power during uploads. A good tracking beam setup can hear the exciter if you place your receiver into USB and listen for the Doppler shifting tone. The satellite is transmitting every pass so you can hear it at night as well.

Please keep in mind that all AO-27 ground controllers have full time jobs. Several have already taken a week of personal vacation from work to spend time on this problem. Equipment used in the ground station has been purchased with the controllers personal funds. This is an all volunteer crew. The best help the amateur community can give is to not flood controllers with e-mail about when is AO-27 going to be back on-line. We are working as fast as satellite passes allow, it takes three days of passes to upload code. Once high level code is running, we will need to spend a week of on-orbit-checkout and gather whole-orbit-data to evaluate the health of AO-27. This is needed for continued longevity of this resource. The popularity and easy of use to Amateurs getting into satellites is very well known to everyone involved in recovering AO-27.

The ground controllers have only one request for amateurs, please do not transmit on the uplink during passes. The analog repeater is turned off so you will not be heard, and you will interfere with the software upload process. Thank you.

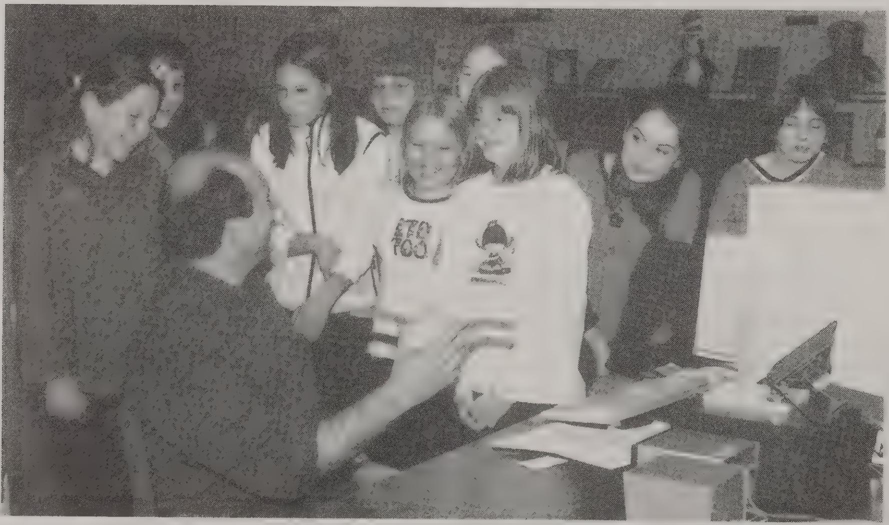

Figure 1: John Santillo, N2HMM and Lounsbury Hollow Middle School students sharing the excitement of their satellite contacts. Note that John is describing how satellite contacts are made using a model of AO-40.

Success on FO-20 with an Arrow Antenna!, by Dave Barrows, W8IJ

I finally made my first contact on FO-20 using sideband. I worked Stan Burghardt, W0IT, at 19:16Z on 28SEP00 using my Arrow antenna in my left hand, and my microphone in my right while I was set up in the back yard. The rig was my FT-726 at a whopping big ten Watt pep output. Thanks to Stan for forgiving my being off frequency with each transmission. I did well to get close enough so he could find me and tune me in.

Things I learned in finally getting the SSB contact:

- I can zero myself by switching the transmit VFO to CW while keeping the receive VFO on USB. The key doesn't work that way, but the push to talk microphone button will key the 726 just fine so I can work the PTT with the same hand I tune the transmit VFO. I just have to be sure to get the transmit (and not the receive) VFO back on LSB before I talk.
- The arrow antenna elements get loose very easily. If they are loose and I transmit on two meters while listening on 70cm, all I hear is a scratching sound and I can't tune anything in. I know now to always tighten all elements before the satellite comes over. I wouldn't recommend my configuration for regular SSB work on FO-20. It is really frustrating. But it can be done under the right conditions.

(*Editor's Note: For additional information on using the Arrow antenna for SSB satellite work, see Chuck Duey, KI0AG's article titled "Tricks, Hints, and Tips for a Portable Satellite Operator" that appears in the proceedings of the 18th AMSAT Annual Meeting and Space Symposium.*)

School Satellite Demonstration a Success, by John Santillo, N2HMM

The Lounsbury Hollow Middle School, New Jersey satellite demo was a tremendous success. The school cleared out most of the library to make way for the students and revised class schedules so they could be apart of the demonstration. Most of the student body and half the staff participated in the demonstrations.

My station comprised of a FT-847 with shortened KLM antennas. The antennas were a KLM 40CX and 20CP but due to a storm knocking down my tower a couple months back, the front two-thirds of the antennas were destroyed so I only used the rear sections of the antennas. The antennas were controlled manually and despite that they worked very well.

A free lance reporter spent more than two hours photographing and documenting satellite communications and Amateur Radio discussions in general (Figure 1). It really was a lot of fun. I would like to thank everyone for letting me *hog the birds*.

We logged the following stations:

K6YK, KC8IDG, VA3BJD, KB0RQ, VA3PKF, VA3PJB, K8KFJ, W7JPI, VE3OKS, N5ZML, VE2DIV, KA8IJY, N1ORC, KB2WQM, AA1WI, WB4FWQ, KB5EBA, N3JCS, K5OE, KC8LTL, N3MIQ, 1ORC, N7SFI, KG4JAR, KC0GN, KC2GNV, WH2ALC.

I apologize if I left anyone out or got the calls wrong but there were times when the school staff just couldn't log fast enough. (I had to give them something to do while I was having all the fun.) The calls are in no particular order.

Again thank you all for your participation.

First ARISS School Selected for Contact

Students at an Illinois school are set to be the first to talk via Amateur Radio with the crew of the ISS, as part of the Amateur Radio on the International Space Station—or ARISS—program. The Burbank School in Burbank, Illinois is tentatively scheduled to have a QSO with the Expedition 1 crew in December. An exact date has not been set, and the schedule remains at the mercy of the crew's heavy work schedule.

The Burbank School applied for a Space Amateur Radio EXperiment (SAREX) QSO in January 1996, and its application is currently the one waiting the longest in the files. Another 18 schools are under consideration for ARISS school contacts. Burbank School has chosen 12 students to speak to the Expedition One crew. The entire school has organized educational activities that revolve around the International Space Station. Teachers throughout the school are using AMSAT and ARRL news articles as teaching materials.

A design contest for a logo to be used at the educational event was held, and the winning logo will be featured on T-shirts. Charles Sufana, AJ9N, is the AMSAT school mentor for the Burbank School. Charles anticipates reporting on the results of this contact in a future issue of *The AMSAT Journal*.

TAPR Elects Officers at 19th Annual Digital Communications Conference

John Ackermann, N8UR, was elected the new president of TAPR at the 19th ARRL/TAPR Digital Communications Conference (DCC) held in Orlando from 21-24 September 2000.

Over 135 hams, including a dozen from outside the US, attended the annual event, which includes presentation of technical papers, hands-on demonstrations, and beginner's sessions. Over 100 people attended Friday afternoon's APRS seminar, and 70 were present for a technical symposium on programming PIC chips held Sunday morning.

Ackermann succeeds Greg Jones, WD5IVD, who had served as President since 1993, with Steve Bible, N7HPR, replacing Ackermann as Vice President. Bob Hanson, N2GDE, will continue to serve as Secretary, and Jim Neely, WA5LHS, remains Treasurer. The elections were held at TAPR's annual board meeting, held in conjunction with the DCC.

Satellite DXpedition to Costa Rica. Dennis Morris, WA4ZJJ and Eddie Wilson, K4QFF/TI8 of the Pine Mountain DX Rangers recently took a DXpedition trip to Costa Rica where they worked UO-14, AO-27, and SO-35. WA4ZJJ reports that is was great hearing such nice signals in Central America. They did not hear any activity in South America as the southernmost stations worked were TI5KD, XE1MEX and XE2YVW. There are five satellite operators in the Pine Mountain DX Rangers and at least one of them (K4QFF) will be returning frequently to Costa Rica. A special thanks is due to KK5DO, K5OE and K4WZ, who assisted them in a number of ways. Also thanks to Keko Diez, TI5KD who visited them in Quepos, and graciously hosted them at his home, and who is now an active satellite operator. Keko plans to activate additional grid squares and to recruit new satellite operators in Costa Rica and in adjacent countries. The team thanks to the entire satellite community for letting them have more than their fair share of satellite time to pass out EJ79 grid square contacts.

"Greg Jones led TAPR through a period of growth and innovation," Ackermann said. "On his watch, we brought significant new products to market, including the DSP-93 digital signal processing unit, Totally Accurate Clock, and Mic-E and Pic-E data encoders. Greg also laid the groundwork for our Frequency Hopping Spread Spectrum Radio project. He guided us into the Internet age, along the way creating the TAPR SIG mailing lists that now handle thousands of messages per month. Greg is also responsible for our increased publishing activities. His retirement leaves a void in TAPR that will be hard to fill."

Ackermann said that his primary objective will be to ensure that TAPR remains on the cutting edge of radio technology, with a special emphasis on emerging concepts such as Software Defined Radios. He will also focus on increasing membership and optimizing the organization's management structure.

Ackermann (ex-AG9V), who lives in Dayton, Ohio, has served on the TAPR Board of Directors and as vice president since 1995. He was first licensed in 1974 and has helped build packet radio networks in Ohio and Wisconsin. Ackermann is active on APRS, runs a Linux-based Internet site at his home, and can occasionally be found on CW chasing DX.

Bible lives in Kingsland, Georgia, and has been a TAPR Board member since 1996. He was project manager for TAPR's Totally Accurate Clock (TAC-2), EVM Radio Interface, PIC Encoder, and DGPS Reference Station kits. Bible is leading TAPR's development of a road map to develop Software Defined Radio technology for amateur use.

In other news from the TAPR DCC:

- TAPR announced that it will soon be offering the *EasyTrak* satellite rotor and radio controller. This PIC-based unit will control azimuth and elevation rotors for satellite use, as well as tune popular radios for Doppler correction.
- PRUG, the Packet Radio Users Group of Japan, demonstrated the possibilities of low cost Internet-connected sensors and software mobile agent technology. PRUG also introduced the TINI-AMEDES, a Java based one-board computer with Ethernet interface which supports the Dallas Semiconductor 1-wire interface, and provided an update on their 2.4GHz spread spectrum radio, which has been commercialized by Root, Inc.

DCC 2001 will be held in Cincinnati, Ohio from 21-23 September 2001. Conference coordinators will be Steve and Sheila Bible assisted by local coordinator Hank Greeb, N8XX. ■

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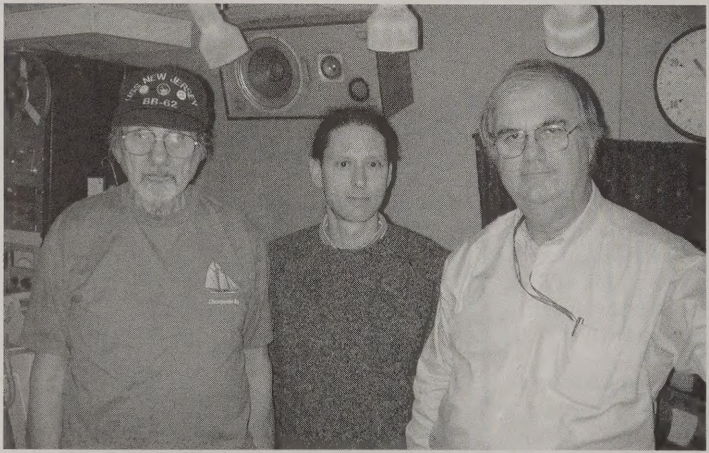
Where Were You When Phase 3D Was Launched?

Tom Clark, W3IWI leads a group of AMSAT-DC members at W3PK's QTH in a victory toast. Left to right are W3IWI; Dick Daniels, W4PUJ; Paul Rinaldo, W4RI; Perry Klein, W3PK; Art Feller, W4ART; Martha Saragovitz, AMSAT Corporate Secretary; John Shew, N4QQ; Jim Randall, N3YDT; Bob Carpenter, W3OTC.

Vince Fiscus, KB7ADL at his QTH in Billings, Montana watching the web, tracking along with InstantTrack, and listening to Keith Pugh, W5IU on the telebridge frequency 14.282 MHz.

Celebrating AO-40 (L-R) Shari Harlan, N9SH, Bob Davidson, WA9NTT (in front), Rich Ludwig, K9PK, with Sarah and Katie; and Gene Harlan, WB9MMM in Rockford, Illinois. Gene and Shari publish *OSCAR Satellite Report*.

Goddard Amateur Radio Club President Hugh O'Donnell, W3FUO, in the WA3NAN Re-transmissions Facility equipment room where four operators logged 118 check-ins on the ALINS frequencies.

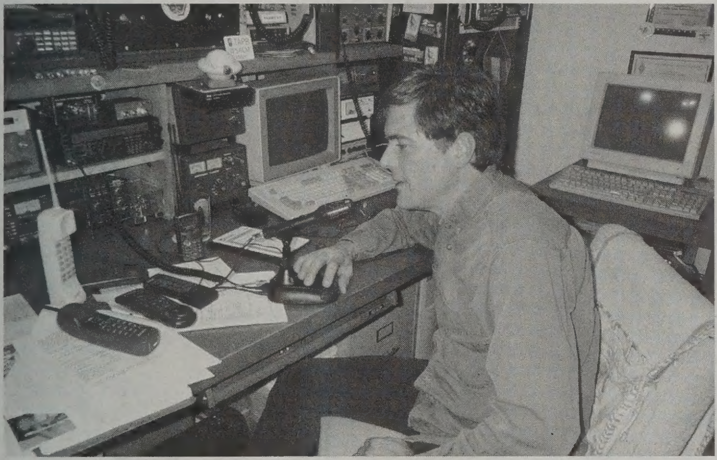


(Right to left) John Stolarik, K3CLG; Ken Stewart, KF3DC; and John Gainsborough, KM6LJ, at the WA3NAN Re-transmission Facility. K3CLG was AMSAT Net Control Station on 7.185 MHz, KF3DC was NCS on 3.860 MHz, and KM6LJ was NCS on 21.395 MHz. John Klim, N3KHK (not pictured) was prepared as NCS on 28.650 MHz from a remote location but the band was not open at the time. The AMSAT rogram was also transmitted locally in the greater Washington, D.C. area on 147.450 MHz simplex.

Pat Kilroy, N8PK, at the WA3NAN Re-transmissions console. N8PK was NCS on 14.292 MHz, down 3 kHz from the planned frequency due to another net already in progress, and then he initiated the simulcast on five bands covering the USA, Canada and Oceania.

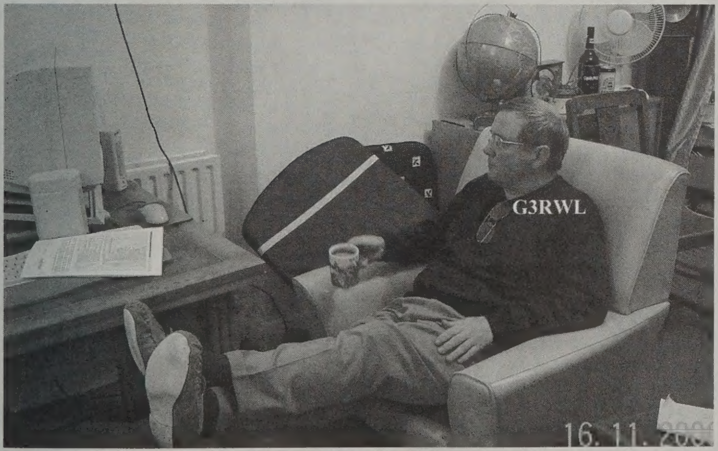
Phase 3D Integration Laboratory Manager, Lou McFadin, W5DID; AMSAT VIP for User Services Barry Baines, WD4ASW; and AMSAT VP for Engineering Stan Wood, WA4NFY share a celebration toast in Orlando, Florida. (Photo by Mary Wood)

Mark Hammond, N8MH in his shack in Coats, North Carolina turning helices during the Phase 3D launch!



Andy MacAllister, W5ACM during the Phase 3D ALINS. Andy patched the ALINS phone bridge to the local repeater (WB5RDK/R on 145.45 MHz) along with a mix of the Arianespace C-Band G4R feed. Bruce Paige, KK5DO uplinked to a RealAudio feed and the W0KIE satellite network.

Celebrating the successful launch of Phase 3D at Don DeJarnette, KC4YRT's QTH in Tuscaloosa, Alabama are (l-r) Joel Black, K2SAT; Herbert Connellan, KD4Y; and KC4YRT. Note the Ariane 5 designed toast with 7-Up and Diet Pepsi as the solid rocket boosters! (Photo by Sydney DeJarnette, KD4APD)



Richard Limebear, G3RWL, comfortably monitoring the Phase 3D launch during the wee hours of the morning at his QTH in Middlesex, England.

(L-R) Jeff Sykes, K5VU; Russ Tillman, K5NRK; Jerry Brown, KC5DNY; and Eddie Pettis, N5JGK make a toast during a post-launch victory celebration breakfast at a Waffle House in Vicksburg, Mississippi. (Photo by Angela, a Waffle House waitress)

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